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MASTER MECHANICS' ASSOCIATION.

THE THIRTY-EIGHTH ANNUAL CONVENTION.

The convention was opened June 14 at the Oriental Hotel, Manhattan Beach, by the president, Mr. P. H. Peck. Among other matters, his annual address briefly mentioned the AMERICAN ENGINEER tests, announcing the fact that the necessary funds for that work were in the hands of the association. The speaker also referred to the tests on locomotive boilers which are to be undertaken in the future. The adoption of representative membership of the association—which had already met with responses representing about 25 per cent. of the total number of locomotives in the country—would provide funds for such investigations in the future. The president thought that much valuable work could be done in standardizing locomotive parts, as had been done by the Master Car Builders' Association. In the matter of shop practice, he deplored the conditions requiring "100-ton locomotives to be maintained in 50-ton shops." The address was brief, and touched upon the most important work before the association.

The report of the secretary showed the total number of active members to be 738; associate, 17, and honorary, 38; a total of 793. The secretary announced that the amount in hand for the AMERICAN ENGINEER tests was $3,077.34. According to the change in the constitution last year, the railroads had been invited to appoint representative members, responses having been received from 30 roads. The secretary explained that no increase of dues was contemplated, the cost of conducting tests and experiments, however, would be provided by assessments among the railroads through representative membership.

The treasurer's report showed a balance of $1,535.29 in the treasury, with all bills paid.

At this point Mr. Edward Sauvage, consulting engineer of the Western Railway of France, was given the privileges of the floor. They were also given to Mr. J. D. Benjamin, representing the Traveling Engineers' Association. Mr. Godfrey W. Rhodes was elected an honorary member of the association, in view of his retirement from railroad service and his past valuable services to the association. This is a deserved tribute to Mr. Rhodes, than whom no member of the association has been more helpful or faithful for more than 20 years.

COMMITTEE REPORTS.

Some of these reports appear in abstract in this issue and others will appear next month. The discussions will be referred to separately, as follows:

PROPER LOADING OF LOCOMOTIVES.—Mr. C. H. Hogan presented this report, a special feature of which is the list of articles on the subject of loading of locomotives which have appeared in the technical press and before the technical associations. In addition to this list, the report includes opinions of a number of members of the association on the proper assignment of loads, which were very briefly stated. Mr. Hogan emphasized the importance of reducing the number of cars to carry a given load, and strongly recommended the use of dynamometer cars in rating locomotives. Mr. Wallace (D., M. & N.) thought that the rating of locomotives should be left to the officers on the divisions where the engines are used. Mr. H. H. Vaughan (Canadian Pacific) thought it would be valuable to know from a number of roads the percentage of theoretical tonnage which could be handled satisfactorily. He considered it economical to carry as heavy a load as practicable without taking too long time on the road. The time was more a transportation than a mechanical question. Reductions could be made occasionally when special conditions caused undue detentions. His remarks tended toward the opinion that, within reasonable limits, (say speeds of 10 to 15 miles an hour), the heavier locomotives are loaded the better. He would like to know of any use of a reduced rating to take care of poor condition of engines because of having been long out of the shops. Mr. G. R. Henderson pointed to the facts that schedules are usually prepared by transportation officials without considering mechanical questions, and that officials gave a high place to large tonnage without considering whether it was economically handled. Mr. F. H. Clark (C., B. & Q.) agreed with Mr. Vaughan as speeds of 10 to 15 miles per hour, the economical loading of locomotives being that which may be handled at such speeds.

Mr. E. Sauvage spoke of locomotive loading methods in France, where fictitious grades were used in order to take account of momentum. Tonnages were fixed for fair conditions, and extra premiums were given engineers for taking extra loads. He also referred to the payment of money premiums to engineers in France. Loading was not too heavy in France, because the cost was known to increase with overloading. He spoke too briefly on this important question. Mr. A. E. Manchester (C., M. & St. P. Ry.) spoke of a method whereby the division superintendent kept a daily statement of tonnage handled and coal used to haul it. The figures were almost instantly available, which made it possible to keep very close check on the cost of fuel and the condition of locomotives, the condition being immediately reflected in the cost. He laid special stress upon the necessity of providing "filling up" points, where additional tonnage may be taken if it can be hauled, trains to be started out with loads which would be sure to get over the road. This would interest the men in the tonnage as well as the mileage. Mr. F. M. Whyte suggested paying train and engine crews on the tonnage basis.

LOCOMOTIVE TESTS AT ST. LOUIS EXPOSITION.—Mr. F. H. Clark presented this brief report, and stated that the final records of the tests of eight locomotives at St. Louis were very nearly ready for the printer, and would appear in book form. The committee was continued for report next year.

REPORTS OF COMMITTEES.

LOCOMOTIVE DRIVING AND TRUCK AXLES AND LOCOMOTIVE FORGINGS.—Mr. Forsyth moved that the proposed specifications be submitted to letter ballot. Carried.

SHRINKAGE ALLOWANCE FOR TIRES.—Mr. F. F. Gaines (P. & R. Ry.) did not see why there should be any discrimination as to increasing shrinkage for different diameters. He also approved of heavier wheel treads for cast steel centers. Mr. G. W. West supported the opinion, and had found it desirable to increase the shrinkage to guard against loose tires. Mr. A. E. Manchester believed that a return to the heavy rims used with cast iron was necessary. Cast steel wheels had been made too light to secure sufficient arch effect between spokes. Mr. McIntosh did not consider cast steel at fault, but rather the light sections. Mr. W. E. Symons raised the question of the possible compression of filling blocks of wheels with cut rims. He desired further investigation of this by the committee. Mr. F. M. Whyte spoke of the deformation of the wheel centers by the shrinkage of tires, giving figures from a test which indicated the necessity to strengthen spokes as well as rims. In the early application of cast steel the temptation to save too much weight was yielded to. Mr. Deems moved to refer the subject back to the committee to consider the matter of design of wheel centers, as well as shrinkage of tires.

MOTIVE POWER TERMINALS.—Mr. D. R. McBain presented this report. Mr. H. H. Vaughan spoke of the recent improvements in roundhouses and equipments for them on the Lake Shore and Canadian Pacific roads. He had observed good results with direct radiation systems. Mr. Gaines emphasized the importance of good track arrangements at roundhouses. Ash handling facilities and heating systems were discussed, but nothing new was recommended. Mr. F. M. Whyte had found that mechanical devices for handling ashes do not meet with favor and that a large majority prefer the pit method.

WATER SOFTENING FOR LOCOMOTIVE USE.—Mr. Manchester spoke in favor of tender tank treatment for use as a preliminary to the installation of water treating plants. Mr. Pratt preferred tender tank treatment to no treatment at all. Mr. Walsh expressed appreciation of water treating plants, but he was using tender treatment where the road could not afford to apply treating plants. There was comparatively little discussion.

SERVICE OF LOCOMOTIVES.—This report revealed the surprising fact that the total time which a locomotive is in the hands of the motive power department is usually less than 25 per cent.; that the actual running time was but 28 per cent., and the rest of the time represented absolute idleness of the engine. These figures were obtained in actual service on an important road. Mr. Clark (C., B. & Q.) described a method of keeping track of the time service of locomotives, which, he believed, would accelerate locomotive movements through the roundhouse. Mr. Gaines had found it very advantageous to keep careful records of the movements of engines. This subject hardly received the attention which it seemed to merit.

SHOP LAYOUTS.—This excellent report was presented by Mr. C. A. Seley. This report included Mr. Soule's articles reprinted from the AMERICAN ENGINEER, and dealt with shop facilities, appliances, organization and personnel. It is a strong plea for a broad-minded treatment of the shop question, which makes for efficiency and adequacy in shops to meet the requirements of the times. It is the most important discussion of the subject we have seen—advocating new methods to meet the new needs. This report is worthy of an edition de luxe, to be placed on the desk of every railroad official in the country who has anything to do with actual operation. It is a powerful argument in favor of business methods in providing railroad shops.

Mr. F. F. Gaines spoke favorably of the idea of the large shop, and criticized prevailing methods of comparing output of shops on a unit basis without including a great deal of information not usually given, without which fair comparisons cannot be made. He also discussed the longitudinal *vs.* transverse shops. Professor Hibbard spoke of the personnel, and was glad to see the man question discussed as a shop question. He strongly approved the plan of the Baldwin Locomotive Works in establishing the office of superintendent of apprentices.

LOCOMOTIVE FRONT ENDS.—Mr. Vaughan expressed gratification at the generous response from the roads in supplying funds for finishing the study of the proper relation between stacks and nozzles. The previous work had been found valuable in practice. The question of diaphragms was the most important of the front end questions. It is desirable to design front ends which will be self-cleaning and at the same time interfere as little as possible with the draft.

The committee was continued, and the recommendation to the effect that the results be published in the AMERICAN ENGINEER was carried.

INDIVIDUAL PAPERS.

TECHNICAL EDUCATION OF RAILROAD EMPLOYEES, BY G. M. BASFORD.—This paper, while devoted to education, was really directed toward the questions of labor and organization. It brought out a remarkable discussion, which lasted an hour and a half. Mr. F. F. Gaines had found it necessary to "catch your hare before you cook it," the difficulty being to get the desirable young men. Mr. Tonge (M. & St. L.) pointed to the necessity for providing good foremen, in order to educate apprentices. He did not say how the foremen should be had or how they should be paid. Dr. Goss spoke of the opposition of the men toward apprenticeship, which he felt sure would be overcome, as the workman cannot object to the principle of training his own son. He spoke with admirable clearness and decision of the necessity for making apprenticeship attractive. Separate organizations for caring for apprentices had been found necessary in manufacturing establishments, and would probably be necessary also on railroads. Mr. W. D. Robb (Grand Trunk) described the apprentice system of that road with its 40 per cent. of apprentices. This interesting statement will be referred to again in this journal. Undoubtedly Mr. Robb's apprentice system is the most extensive on this continent. Mr. George West (N. Y., O. & W.) stated his opinion that the secret of success in an apprentice system was "foremen and fairness." Mr. J. F. Deems believed that boys were about the same as they were 40 years ago. He said "there is no question to-day confronting the railroads of this country that is so important in all its bearings and ramifications as this question of the proper education of the employees of the railroads." Mr. Parkes (Michigan Central) described the apprentice system of that road, and supported the arguments in favor of apprentice schools. Mr. J. F. Walsh (C. & O.) gave strong support to the paper, and specially to the contention in favor of placing all apprentices on the same level, whether technical school graduates or not. Mr. W. E. Symons wanted to see the apprentice, the foreman and the master mechanic properly paid. "A man will not endure years of hardship and privation" for such poorly paid positions. Mr. S. W. Miller (Pennsylvania Lines) made an excellent presentation of the question from the point of view of a successful master mechanic, who had been a special apprentice after completing a technical school course. He did not agree with the author of the paper as to the special apprentice, but said: "I do not believe that ten years, on the average, is any too long for a young man to serve as a special apprentice." The speaker showed the importance of knowing the men and getting "close to them" in the shop. Others added very valuable remarks to the discussion. The tone of the remarks indicated that great progress has been made in the attitude of railroad men toward the apprentice.

SUPERHEATED STEAM IN LOCOMOTIVES.—Mr. Vaughan briefly reviewed his admirable paper. He considered the Pielock as the most promising theoretically, but he doubted its success practically. As to results, he considered the fact that the superheater was shown to be "as good as a compound" to be very important. On 4 months' records the Schmidt superheater had saved 10 per cent. over the 2-cylinder compound and the Cole superheater had shown itself to be as good as the compound. Lubrication was mentioned as a most impor-

tant necessity in the use of superheaters. He believed it possible to use sight feed, displacement lubricators. It was not sufficient to oil the valves and expect the oil to go down to the cylinders. The cylinders must be oiled separately. The speaker believed it practicable to reduce boiler pressures to 175 lbs. in connection with superheating, thus gaining an amount in cost which would offset the extra cost of applying superheaters. The paper was received with hearty applause of appreciation. Later he said that he considered the superheater to stand about 10 per cent. better than a compound, basing this upon records varying considerably, but taken in actual service. Mr. Whyte expressed the opinion that if 10 per cent. on the total coal bill could be saved by the superheater which was in use only when the cylinders were using steam, the superheater furnished the best possible method of helping the fireman. The paper was so complete and satisfactory as to lead to no criticism and little discussion. Mr. Sauvage stated that Mr. Vaughan's paper and the data he had obtained in this country would lead him to be more eager to see superheating tested in France. Mr. Vaughan wound up the discussion by stating that the Canadian Pacific would soon have 106 superheater locomotives in service. He was prepared to believe that superheating offered a satisfactory reason for not using compounds. No matter what could be said in favor of compounds, it was generally understood that they had more engine failures than simple engines. He stated plainly that the superheater engines were the best on the road from the roundhouse standpoint.

TOPICAL DISCUSSIONS.

WATER SPACES AROUND FIREBOXES.—Mr. Lawford H. Fry presented a brief statement which appears in this issue on page 247. Mr. T. H. Curtis (L. & N.) referred to the breakage of staybolts, and stated his belief that there was an unknown law governing breakage, in which the boiler pressure was an important factor. In answer to a question, Mr. F. H. Clark spoke of ¾-in. staybolts, spaced 3 ins. apart, which were applied to a number of new engines, but no definite results had yet been obtained. Mr. Deems confirmed Mr. Fry's statement as to the desirability of placing the outer firebox sheet vertically in order to avoid conflict of the bubbles of steam from the inside sheet with down-coming cold water. Mr. A. E. Mitchell supported the idea of vertical outside sheets. Mr. Fry wanted to be understood as referring specially to fireboxes in which the sheets were approximately parallel. W. E. Symons believed that the character of the water decided questions of design of fireboxes. Dr. Goss believed it impossible to get the water spaces too wide at the mud ring, and that the spaces should widen as rapidly as possible above the mud ring. Mr. C. A. Seley stated that 4½-in. mud rings were adopted by the power committee of that road, the water spaces being the same width all around.

The topical discussion on relief and by pass valves resulted in ordering the subject referred to a committee to report next year; so also did the discussion on automatic locomotive stokers.

A resolution was passed thanking the contributors to the fund for the continuation of the AMERICAN ENGINEER tests.

A resolution was passed amending the constitution to provide for executive members in the same manner as provided in the constitution of the Master Car Builders' Association, which increases the number of officers by adding six executive members.

The attendance at the convention was unusually large, the number of members registered being 298. This year the exhibitors numbered 220, covering 40,000 sq. ft. with exhibits, not including passageways. Last year 187 exhibitors used 25,000 sq. ft. of space. The exhibits were well attended and carefully studied.

Messrs. Deems, A. W. Gibbs and A. E. Mitchell were appointed a committee to aid in inaugurating a master mechanics' dictionary, to be published by the *Railroad Gazette*.

The election of officers resulted as follows: President, H. F. Ball; first vice-president, J. F. Deems; second vice-president, William McIntosh; third vice-president, H. H. Vaughan; treasurer, Angus Sinclair; executive members—G. W. Wildin, C. A. Seley, A. E. Mitchell, A. E. Manchester, J. F. Walsh, F. H. Clark; secretary, J. W. Taylor.

The convention adjourned June 16 after very successful meetings, in which the discussions were exceedingly well conducted.

MASTER CAR BUILDERS' ASSOCIATION.

THIRTY-NINTH ANNUAL CONVENTION.

This convention was called to order by the president, Mr. W. P. Appleyard. In speaking of the interchange rules, he hoped that the "golden rule" would continue to guide the association in governing the interchange of cars in the greatest nation in the world. There had been but 15 arbitration cases submitted to the arbitration committee during the year, and this indicated the satisfactory way in which the rules were working. This year a question of damage by flood was to be brought before the association. Electric traction and its probable effect upon the problems of the association was pointed out as a subject to be provided for. The steam railroad would soon have active competitors. The president spoke impressively of the necessity of educating the men who are to carry the responsibilities of the future. The paper on the subject of education of recruits, read by Mr. Basford before the Master Mechanics' Association, was recommended to the attention of the association. Japan's success in the present war constituted an example showing the importance of education and preparation. Among references to equipment matters more side-play to couplers was considered desirable, and all possible steps toward a standard coupler should be taken. The address was high-minded, thoughtful and polished, and it inspired the convention with a serious purpose in beginning its work. It established a tone for the convention which was sustained to the end.

The report of the secretary and treasurer showed a bank balance of $4,545.42. The total membership was stated to be 607.

A change in the constitution was proposed, having for its object an extension of the scope of eligibility for membership.

Mr. Edward A. Moseley, secretary of the Interstate Commerce Commission, addressed the association. His chief subject was the application and administration of the safety appliance law. The law had met with responses beyond the greatest expectations of those responsible for it. The number of cars found defective by the inspectors of the commission had been reduced in a remarkable manner, indicating the spirit of the roads in carrying out the law. The speaker expected soon to see the interchange rules practically the same as the law of the land. His remarks were very complimentary to the railroads.

COMMITTEE REPORTS.

TRIPLE VALVE TESTS.—Mr. McIntosh (C. R. R. of N. J.) presented the subject. The report was accepted and the recommendations adopted without discussion.

BRAKE SHOE TESTS.—Dr. Goss read the report in abstract. It was accepted without discussion.

REVISION OF STANDARDS.—Mr. C. A. Schreyer (C. & N. W.) presented the report. These concerned dust guard plates, journal box lids, wedges, brake heads and shoes, brake beams, coupler yokes and other details contemplating their improvement in important ways, but without radical changes. All but the proposal to increase the length of standard brake shoes were ordered referred to letter ballot. Mr. R. P. C. Sanderson (Seaboard Air Line) stated that he had recently learned that in New Zealand the rules of the M. C. B. Association were considered satisfactory evidence of good and safe practice before the law courts. This was advanced as a reason for hesitating to complicate the rules by changes not positively necessary.

AIR BRAKE HOSE.—This report recommended the specifications for hose which were proposed last year and the adoption of M. C. B. standard hose, providing for such hose in the interchange rules, which has never been done. The specifications were intended to provide a satisfactory quality without unnecesarily increasing expense. The report included records of tests at Purdue University, showing that a large quantity of poor hose is being used to-day. Providing for improved hose in the rules would compel its use in interchange. Mr. A. W. Gibbs (P. R. R.) thought that the committee ought to provide in the specifications for hose which is not wrapped—that is, woven hose. The report was referred to letter ballot.

TESTS OF M. C. B. COUPLERS.—This important report constituted a step toward a standard coupler. The report gave evidence of careful work and carefully considered conclusions. In the test of unit stresses on knuckle pins the present lack of uniformity was indicated by the variation between 41,000 and 85,000 lbs. per sq. in. in ultimate load. In the discussion Mr. Sanderson argued against the abolition of the slots in couplers, as this would cut out a certain promising development in draft gear. He wished to see recommendation No. 7 (by the committee) removed before the matter is referred to letter ballot. The report was referred to letter ballot in such form as to provide for retaining the key slot in coupler stems, but not to provide for continuous draft gear.

TRUCK ARCH BARS.—The recommendations of this report were referred to letter ballot without discussion.

SAFETY APPLIANCES.—This report was not printed in advance of the convention. It was considered too important for immediate action, and was referred to the committee on standards for report next year. No discussion.

STEAM LINE CONNECTIONS.—This subject was referred to a committee to report a standard steam hose coupler next year.

REPAIRS OF STEEL CARS.—This report discussed the splicing of sills of steel cars when it is necessary to cut them within a distance of 8 ins. from the bolsters. The committee recommended splices, which were ordered referred to letter ballot.

STENCILING FREIGHT CARS.—The recommendations were accepted by the association, to be presented later for letter ballot for adoption when the work of the committee is completed.

INTERCHANGE RULES.—The decisions of the arbitration committee in cases decided during the past year were approved as a whole by a unanimous vote. The established high standing of the work of the arbitration committee was sustained by the association by the adoption of all of the recommendations of the arbitration committee with respect to changes in the rules. In the matter of responsibility for damage to cars by flood when away from home a spirited discussion was held, resulting in sustaining the arbitration committee in its decision, ruling, in effect, that storm or flood does not relieve a railroad of responsibility for damage to borrowed cars. The interchange rules were completely disposed of in *one hour and fifteen minutes*, which is the best possible tribute to the work and influence of the arbitration committee.

RULES FOR LOADING LONG MATERIALS.—This report illustrated the importance of the "get together" methods employed by this association. At the opening of the convention several interests were far apart in their opinions. By meetings and conferences these differences were adjusted, and the report of the committee after its amendment was referred to letter ballot for adoption.

SAFETY CHAINS.—This committee believed that better permanent safety chains could be devised, and presented suggestions for temporary chains for use on cars carrying double loads. The recommended chains were referred to letter ballot for adoption, the committee being continued for further report next year.

LOSS OF CARS IN FLOODS.—This subject was brought up again by the executive committee in the form of a resolution to the effect that if the recent loss of cars in floods on roads running out of Kansas City was not made good to the owners in accordance with the decision of the arbitration committee, the roads refusing should be deprived of the benefits of the interchange rules and expelled from the association. Mr. W. E. Symons argued in defense of those roads, ably representing their interests. Mr. Seley of the Rock Island followed with objections against expelling these roads, calling attention to the action as probably being unconstitutional. Mr. Seley believed that the matter was beyond the authority of the association, and should be settled by the officers of the roads involved, and, if necessary, by legal recourse. Several speakers questioned the desirability of such a drastic measure as the passage of the resolution. Several favored further attempts at adjustment. Mr. Sanderson amended the resolution to remove the penalty, thus plainly expressing the position of the association in sustaining the arbitration committee, but removing the penalty clause—this established peace with honor, after a vigorous, tense debate.

GUARANTEE FOR CAST IRON WHEELS.—This report presented the opinions of the wheel makers—a result of an effort to get the users and makers of wheels together in a general form of guarantee. The report was not printed in advance of the convention. The subject was referred to a standing committee on cast iron wheels, this committee to consider the complete contour of wheels, and to specially consider the possibility of increasing thickness of flanges.

DOORS.—The recommendations of this report were referred to the executive committee.

TOPICAL DISCUSSIONS.

SERVICE OF CAST IRON WHEELS.—The new M. C. B. wheels had not been in service long enough to establish conclusions, but those which had been in use had given a good account of themselves. It seemed probable that the association had not made a mistake. Mr. Fowler stated that many railroad officers doubted the advisability of using cast iron wheels at all under 100,000 lbs. capacity cars. He quoted tests showing pressures required to break off flanges of wheels. Stresses to which flanges of wheels are subjected were believed to constitute an important field for investigation by the association.

GREATER BRAKING POWER ON FREIGHT CARS.—Mr. F. M. Gilbert raised the question of how braking power could be increased without introducing undesirable complications. The speaker believed that train line pressures should be increased. There was no discussion.

HEIGHT OF COUPLERS OF PASSENGER CARS.—Mr. T. H. Curtis directed attention to the importance of straightening out the present wide variations in the height of couplers and platforms. A number of speakers expressed definite opinions as to the need of action by the association. It was ordered referred to a committee for report next year.

RIVETING YOKES.—Introduced by Mr. William McIntosh, who explained the reasons why it is desirable to strengthen the attachment of yokes to couplers. Mr. Garstang thought that all holes in drawbar yokes and coupler stems should be drilled. Mr. Deems showed that coupler yoke attachments should be greatly improved by good fitting, in order to withstand the stresses produced by heavy engines. Mr. Hennessey referred to weakness in the coupler shanks, which were too thin at the ends. Mr. Fowler referred to the desirability of good fitting, which would permit of securing the full benefit of the lips at the ends of the shanks to relieve the rivets of strain. Mr. Hennessey stated very plainly that good fitting was not now being done. The size of rivets should be increased. "The poor inspector who tries to get good fitting at contract shops is up against a hard proposition." Mr. West said that the scrap pile was a great educator on this question, 90 per cent. of the breakages found were at the fastening. Mr. Garstang's motion was amended, and the matter was referred to the coupler committee for recommendation and specifications for future construction. Mr. Ball argued in favor of a flexible

attachment using a 2¼-in. pin in a knuckle joint, which he proposed last year and had used successfully in practice, believing that an attachment better than riveting should be considered. The subject was ordered referred to the coupler committee for report next year.

The following officers were elected: President, Joseph Buker; first vice-president, W. E. Fowler; second vice-president, G. N. Dow; third vice-president, R. F. McKenna; treasurer, John Kirby; executive members—H. M. Carson, G. W. Wildin, T. H. Curtis.

Mr. C. W. Martin, speaking for the supply men's organization, stated that, from their standpoint, this had been the "best convention" the association had ever held.

The association adjourned after a record-making convention of which the retiring president, Mr. W. P. Appleyard, should be proud.

NOTES OF THE CONVENTION.

Mr. Moseley, secretary of the Interstate Commerce Commission, upon request defined what the expression "going between cars" actually means. It now applies to actual coupling, and the law says that men shall not be obliged to go between cars at all. Strictly interpreted, this prohibition applies to the coupling of air hose, and the speaker referred to progress which is making in automatic devices for coupling air hose, indicating that the day will come when such devices would be generally used. Mr. Moseley emphasized the obligation of the railroads to see that the safety appliances of cars are in good order before accepting cars in interchange.

The importance of the interchange rules and the smoothness of their operation were indicated in conversation with a prominent master car builder. This gentleman said: "We have collected $261,000 from other roads for repairs to cars during the past year. Ninety per cent. of these transactions were conducted upon honor, without the slightest question or friction."

Indicating the extent of flange breakage, one speaker stated that on his road over 1,000 cases had been discovered in a single year.

A visitor familiar with railroad matters, who attended the M. C. B. Convention for the first time, remarked: "This is the most businesslike lot of able men I ever listened to. The earnest but good-humored way these people discuss important questions, where opinions differ, is a wonder." He undoubtedly referred to Mr. Schroyer's breezy manner of keeping everybody good-natured.

It would be difficult to find an organization of men whose discussions are as businesslike, direct and full of "meat" as those of this association at this convention. The discussions were models, which should be an example to other organizations of technical men.

100,000-POUND STEEL ORE CAR.

DULUTH, MISSABE & NORTHERN.

This is a short, strong car built by the Standard Steel Car Company specially for ore service on this road. It is built throughout of structural steel, with 15-in. channel center sills and 6-in., 10½-lb. channel side sills. The side stakes are of channels and angles. The light weight is 32,200 lbs.

In ore cars it is necessary to arrange the doors specially to suit the material. In this case four doors are operated in pairs, hung transversely across the openings and arranged to dump the load between the rails. This gives a large opening with a short wheel base. The doors are supported on their outer ends by chains passing over pulleys, the chains being operated by transverse shafts located under the hoppers at each end, and manipulated by the hand wheels shown in the photograph by means of gears and pinions. The air brake cylinder is hung from the lower face of one of the side sills, the releasing spring being placed on an outer extension of the piston rod. These cars are equipped with Westinghouse brakes, Simplex bolsters, Symington & McCord journal boxes, and Susemihl side bearings and Westinghouse friction draft rigging. The leading dimensions are as follows:

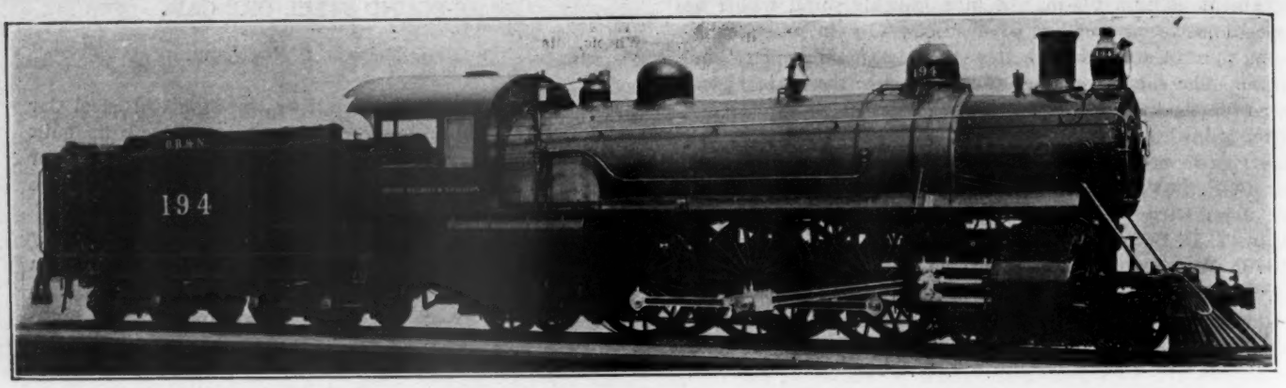
100,000-POUND STEEL ORE CAR—DULUTH, MISSABE & NORTHERN RAILWAY.

Length over end sills	22 ft.	0 ins.
Length of care inside of body	20 ft.	7 ins.
Width of car over side stakes	8 ft.	6 ins.
Width of car inside of body	7 ft.	11⅝ ins.
Height from top of rail to top of body	9 ft.	0 ins.
Height from top of rail to top of brake mast	9 ft.	6½ ins.
Length of drop doors in clear	6 ft.	8 ins.
Width of drop doors in clear	3 ft.	6 ins.
Height from top of rail to center of coupler	2 ft.	10½ ins.
Distance from center to center of trucks	13 ft.	6 ins.

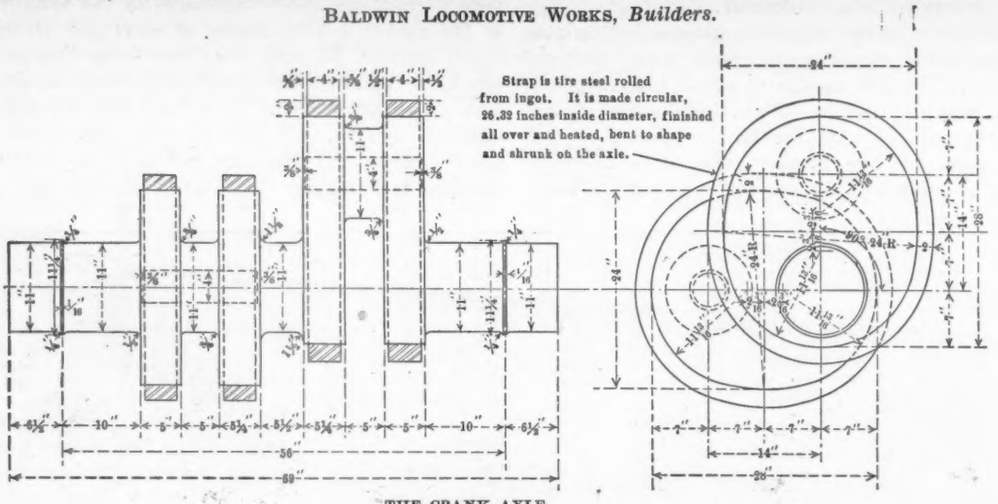
MAINTAINING 10,000 LOCOMOTIVES.—There are 12 railroads entering Buffalo. These 12 roads own and operate 10,000 locomotives. The boilers of these locomotives contain about 19,000,000 rivets, 3,000,000 tubes, 13,000,000 staybolts, radial and crown stays.—*F. W. Williams, before Master Boilermakers' Association.*

Mr. George L. Wall has resigned as assistant engineer of motive power of the Pennsylvania Company at Fort Wayne, Ind., to become mechanical engineer of the Lima Locomotive Machine Company, Lima, Ohio.

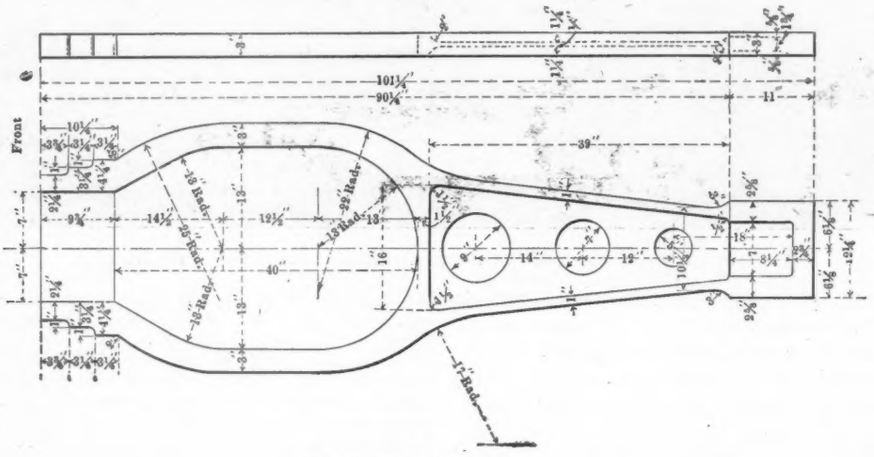
Mr. Charles M. Hoffman, road foreman of engines of the Burlington at St. Joseph, Mo., has been appointed master mechanic of the Southern Railway, with headquarters at Princeton Ind. He has been in the service of the Burlington since July 1st, 1887.



PACIFIC TYPE, FOUR-CYLINDER BALANCED COMPOUND LOCOMOTIVE—OREGON RAILWAY & NAVIGATION COMPANY.
BALDWIN LOCOMOTIVE WORKS, *Builders.*


Strap is tire steel rolled from ingot. It is made circular, 26.32 inches inside diameter, finished all over and heated, bent to shape and shrunk on the axle.

THE CRANK AXLE.



BIFURCATED MAIN ROD.

4-CYLINDER BALANCED COMPOUND PASSENGER LOCOMOTIVE, PACIFIC TYPE.

OREGON RAILROAD & NAVIGATION COMPANY.

In this locomotive, built by the Baldwin Locomotive Works for the Oregon Railroad & Navigation Company, the Vauclain 4-cylinder compound arrangement was applied to a 6-coupled engine, being the first use in this country of the balanced principle in a locomotive of more than four coupled wheels. The cylinders are all in line, the intermediate axle is the crank axle and the high pressure cylinders are coupled to it by means of bifurcated main rods. This is an exceedingly important design, because if its expected success is attained it will open the way for the balanced compound principle for the heaviest passenger service, and it will show one way to accomplish this result.

This is a very heavy locomotive, weighing 231,300 lbs., which is 800 lbs. more than the Erie Pacific type locomotive, illustrated in May, page 172. In fact this new locomotive is the heaviest of its type and is the heaviest in passenger service except the Class K of the Lake Shore, which weighs 233,000 lbs. (See AMERICAN ENGINEER, 1904, page 413.)

The construction of this new locomotive as to details is, as far as practicable, similar to the adopted standards of the Harriman Lines, as outlined in May, page 154. The tractive power is 28,300 lbs., and the locomotive is equivalent when running as a compound to a simple engine with 24 4-10-in. cylinders. In starting it is equivalent to a simple engine with 22.4-in. cylinders.

Special attention is directed to the bifurcated rod, which is an element of boldness in design. This rod has been very carefully worked out, and it was made from a billet weighing about 4,000 lbs., the finished rod weighing 1,098 lbs. complete. It is understood that 45 carbon steel was used. The design of the rod is clearly shown in the engraving.

It is made in the form of a fork in order to clear the leading driving axle, and is closed at the front end by the brass crank pin bearing. The manner of providing for the piston pressure stresses is indicated in the form of the rod where the forked and main portions join.

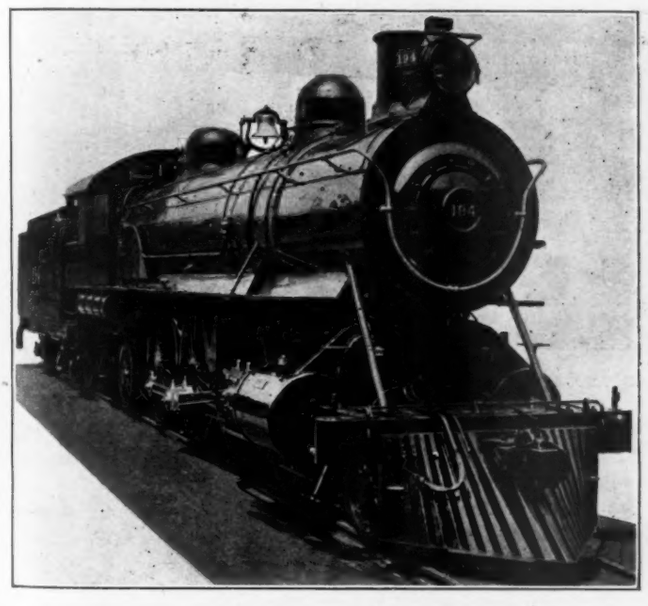
The crank axle is similar to that of the Burlington balanced locomotive by these builders, illustrated in June, 1904, page 213, with slight changes in dimensions.

The photograph showing the side view illustrates the new standard tender for passenger equipment on the Harriman Lines, having a capacity of 9,000 gallons of water and 10 tons of coal. The tender and the cab will be referred to in connection with the further description of the Harriman common standards. A list of dimensions follows.

PACIFIC TYPE BALANCED COMPOUND LOCOMOTIVE, OREGON RAILROAD & NAVIGATION COMPANY.

GENERAL DATA.

Gauge	4 ft. 8½ ins.
Service	Passenger
Fuel	Bituminous coal
Tractive Power	28,300 lbs.
Weight in working order	231,300 lbs.
Weight on drivers	143,600 lbs.
Weight on leading truck	43,400 lbs.
Weight on trailing truck	44,300 lbs.
Weight of engine and tender in working order	390,000 lbs.
Wheel base, driving	13 ft. 4 in.
Wheel, base, total	33 ft. 7 ins.
Wheel base, engine and tender	64 ft. 1½ ins.



PACIFIC TYPE BALANCED COMPOUND LOCOMOTIVE.

RATIOS.

Tractive weight ÷ tractive effort	5.07
Tractive effort x diam. drivers ÷ heating surface	713
Heating surface ÷ grate area	61.7
Total weight ÷ tractive effort	8.17

CYLINDERS.

Kind	Compound
Diameter and stroke	17 and 28 by 28 ins.

VALVES.

Kind	Piston

WHEELS..

Driving, diameter over tires	77 ins.
Driving, thickness of tires	3½ ins.
Driving journals, main, diameter and length	11 by 10 ins.
Driving journals, front and back	9 by 12 ins.
Engine truck wheels, diameter	33½ ins.
Engine truck, journals	6 by 10 ins.
Trailing truck wheels, diameter	45 ins.
Trailing truck, journals	8 by 12 ins.

BOILER.

Style	Straight
Working pressure	200 lbs.
Outside diameter of first ring	70 ins.
Firebox, length and width	108 by 66 ins.
Firebox plates, thickness	⅜ and ½ in.
Firebox, water space	5 ins.
Tubes, number and outside diameter	245, 2¼ ins.
Tubes, gauge and length	0.125 m.m.; 20 ft.
Heating surface, tubes	2,874 sq. ft.
Heating surface, firebox	179 sq ft.
Heating surface, total	3,055 sq. ft.
Grate area	49.5 sq. ft.

TENDER.

Frame	Steel
Wheels, diameter	33½ ins.
Journals, diameter and length	5½ by 10 ins.
Water capacity	9,000 gals.
Coal capacity	10 tons.
Weight of tender loaded, about	159,000 lbs.

WATER SPACES AROUND FIRE BOXES.

TOPICAL DISCUSSION BEFORE MASTER MECHANICS' ASSOCIATION.

BY L. H. FRY.

The question for discussion is: The best known dimensions for water spaces around fire box to produce minimum consumption of fuel and replacement of fire box sheets and reasons for same.

In endeavoring to discover what is known on this subject I made an examination of the water space dimensions of some 84 modern boilers. This investigation showed that there is no generally recognizable rule connecting the size of the water space with the fire box dimensions, but that there is an increasing tendency to use wider water spaces. So many reasons for the use of wide water spaces can be brought forward that it appears strange that the width has not been increased more rapidly. When the fire boxes were restricted in width by being placed between the wheels, the necessity of obtaining all possible grate area made it desirable to keep down the width of the water spaces to a minimum. Now, however, with the wide fire boxes above the wheels, there is but little excuse for reproducing these cramped water spaces. A free increase in the width of the water space around the fire box increases somewhat the dead weight of the engine, but the advantages to be gained will undoubtedly more than offset this.

I do not know of any experiments which will show the influence of the width of the water space on the evaporation, but it is obvious that a free circulation of the water will be ensured by wide water legs and will help the evaporative power of the fire box heating surface. In addition to the size of the water spaces, their shape has considerable influence on the evaporation and life of the fire box.

As the water in contact with the side sheets is turned into steam it must be allowed to rise to the steam space and must be replaced by other waters. The water spaces should be so designed that this natural circulation is aided, and that the currents of steam and water impede each other as little as possible. This is secured if the fire box side sheets are vertical or with a slight slope outward as they rise from the mud ring, so that the steam can rise along the fire box sheets and the water descend along the outside steel sheets without mutual interference.

If, on the other hand, the fire box sheets slope inward in rising from the mud ring, the steam will tend to rise from the side sheets through the water space and along the outer sheets to the surface, thus interfering with the descending water current.

The side sheets, being subject to the full effect of the fire, require an active supply of water to allow the vigorous evaporation to proceed properly. If the water spaces are cramped or badly arranged, so that the water supply is not kept up, the water will fail to reach large areas of the side sheets, with results very detrimental to the life of the fire box sheets and staybolts.

In one case of this sort we found on a certain lot of locomotives that there was a well defined oval space on each side sheet in which it was impossible to keep the staybolts tight until the cause of the trouble was removed by redesigning the water space to give the water free access to the side sheets.

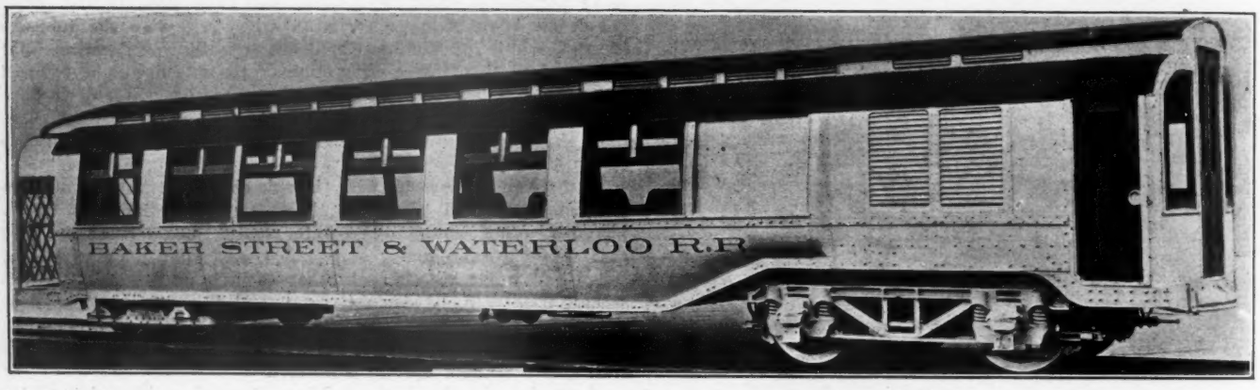
Another advantage obtained by the widening of the water spaces is the increased flexibility and endurance of the staybolts. Some tests recently made on the B. L. W. vibratory staybolt testing machine show the advantage which can be expected from this source. Nine test pieces were cut from the same bar and vibrated with a deflection of 3-32 inch each side of the center while under a load of 4,000 pounds. All conditions were the same except the length of the test piece vibrated. Three bars were 8 inches, three 6½ inches and the remaining three were 5 inches in length. The average number of vibrations before fracture was 1,620 for the 8-inch, 960 for the 6½-inch and 695 for the 5-inch bolts. An increase of 60 per cent. in length of the bolt added more than 130 per cent. to its life when vibrated.

It appears that the rule for the best width of fire box water space is very much like Mr. Forney's rule for the size of a locomotive boiler, which is, make it as large as the other conditions permit. The figures obtained show a wide variation in practice. Among the wide fire box engines the narrowest water space measured as follows: Front leg, 4 inches at mud ring and 5 inches at throat: side and back legs, 3 inches at ring and 4 inches at crown. The widest space had a front leg measuring 5 inches top and bottom; side legs, 5 inches at ring and 6 inches at crown; back leg, 5 inches at ring and 7½ inches at crown.

STEEL PASSENGER CARS.

UNDERGROUND ELECTRIC RAILWAYS, LONDON.

These cars were designed to meet all but impossible conditions, one of which was that the floor should be but 22 ins. above the rails. They are of steel and fireproofed wood. The Berwick Works of the American Car & Foundry Company have built 108 of them, 36 motor cars and 72 trailers, for the London Underground, known as the Yerkes system. One of the motor cars is illustrated. The motor cars seat 46 and the trailers 52 people. Both ends of the trailers are alike with what may be called submerged trucks, while the motor trucks are made more accessible by offsetting the floor over them and raising this part of the floor forming a compartment reached by a flight of three steps. This compartment provides for all of the electric apparatus except that which is attached to the trucks, as there is absolutely no room under the floor of the cars for resistances or anything else. The cars are built complete in this country and erected in temporary shops in Manchester, England. They are to be delivered on an incline in London entering the "Underground."



STEEL PASSENGER CAR—LONDON UNDERGROUND RAILWAYS.

STEEL CARS FOR LONDON UNDERGROUND RAILWAY.

	Motor Cars.	Trailer Cars.
Seating capacity	46	52
Length over car body	42 ft. 9⅜ ins.	41 ft. 11¾ ins.
Length inside passenger compartment	34 ft. 9¼ ins.	41 ft. 2½ ins.
Length inside motor room	7 ft. 7 ins.	
Length over buffers	50 ft. 0¼ ins.	50 ft. 2 ins.
Length over end sills	49 ft. 1½ ins.	49 ft. 1½ ins.
Width inside	8 ft. 1¼ ins.	8 ft. 1¼ ins.
Width over side sills	8 ft. 0 ins.	8 ft. 0 ins.
Width over belt rail	8 ft. 9¼ ins.	8 ft. 9¼ ins.
Width over all	8 ft. 10¾ ins.	8 ft. 10¾ ins.
Width at eaves	8 ft. 2 ins.	8 ft. 2 ins.
Height from rail to top of floor	0 ft. 22 ins.	0 ft. 22 ins.
Height from rail to top of floor in motor room	3 ft. 6¼ ins.	
Height from rail to top of roof	9 ft. 5½ ins.	9 ft. 5½ ins.
Truck centers	33 ft. 0 ins.	33 ft. 0 ins.
Diameter of wheels	36 and 30 ins.	0 ft. 30 ins.
Weight of body	28,000 lbs.	25,000 lbs.
Weight of trucks without motors	17,350 lbs.	13,000 lbs.
Total weight exclusive of electrical equipment	45,350 lbs.	38,000 lbs.

Interesting details of the framing and construction must be reserved until later, the design being specially interesting because of its possible influence upon future passenger equipment construction. One of the motor cars when tested with a load of 105 men and 5,000 lbs. of pig iron in the motor compartment and 500 lbs. on the platforms, deflected a scant 1-16 in. at the center of the sides. The seats are both transverse and longitudinal, the frames being of steel and the seat backs are utilized as a part of the framing.

The cars are 50 ft. 1 in. long over buffers, 49 ft. 1½ in. long over platforms, 8 ft. ¼ in. wide over the sheathing at the sides, 8 ft. 9¼ ins. wide at the belt rails and 9 ft. 5⅛ ins. high from the rail to the top of the roof. The only straight lines in their construction are the floor, the windows and the longitudinal lines of the roof.

The floor is of cement and of course fireproof, with wooden strips, laid over a ¼-in. plate, in fact the car is thoroughly fireproof throughout. The interior finish is of mahogany and the roof of composite board covered with canvas. The interior panels are of Uralite and Transite. Dahlstrom metallic doors are used between the motor compartment and the body of the motor car and the mouldings are of the same material. The seat frames are of steel built into the car and the covering is fireproofed rattan. The motor cab is entirely of steel, including the roof. These cars are mounted upon 30-in. wheels for the trailer trucks and 36-in. wheels for the motor trucks. All of the wheels and axles are of Krupp manufacture. The trucks are of the standard construction adopted by the road, with cast steel frames. The sharpest curves on the line are of 150 ft. radius.

All of the electrical equipment was furnished by the British-Thompson-Houston Company. Other interesting details will be presented later.

In a list of 42 designs of suburban cars for railroads in the United States given by Mr. A. W. Sullivan in his recent paper before the International Railway Congress, the average weight per seat was 942 lbs., the lightest weight per seat being 688 lbs. (for 56-ft. cars carrying 72 passengers on the Chicago & Eastern Illinois). The weight per seat of the London Underground trailer cars is 731 lbs. The heaviest weight per seat in Mr. Sullivan's list is 1,365 lbs., in cars for the Cincinnati, New Orleans & Texas Pacific. In view of the fact that closed trolley cars with longitudinal seats weigh from 600 to 700 lbs. per passenger, the light weight of the steel cars of the London Underground is impressive.

TOPICAL DISCUSSION, MASTER MECHANICS' ASSOCIATION.

ARE SELF-CLEANING FRONT ENDS SATISFACTORY?—Opened by E. W. Pratt.

On the Chicago & Northwestern Railway we think the self-cleaning front end is satisfactory. All our larger classes of power are so equipped, and many locomotives with cylinders as small as 17 and 18 ins.

Out of 1,307 locomotives, over 600 have self-cleaning front ends. By comparing two years before and after making this change we find the amount of coal per 1,000 ton-miles decreased nearly 3 per cent., which I state merely to indicate that the self-cleaning feature has not increased the fuel consumption.

Delays on the road due to dumping cinders from the old style front ends are, of course, entirely eliminated, also the setting fire to engine truck packing from hot front end cinders.

There being no cinders to burn, the change has done away with burned and warped front end frames and doors, particularly where pressed steel shapes are used.

In changing the style of front ends we have not shortened up the extended front, which we believe would be of advantage in the way of obtaining better draft with still larger exhaust nozzles.

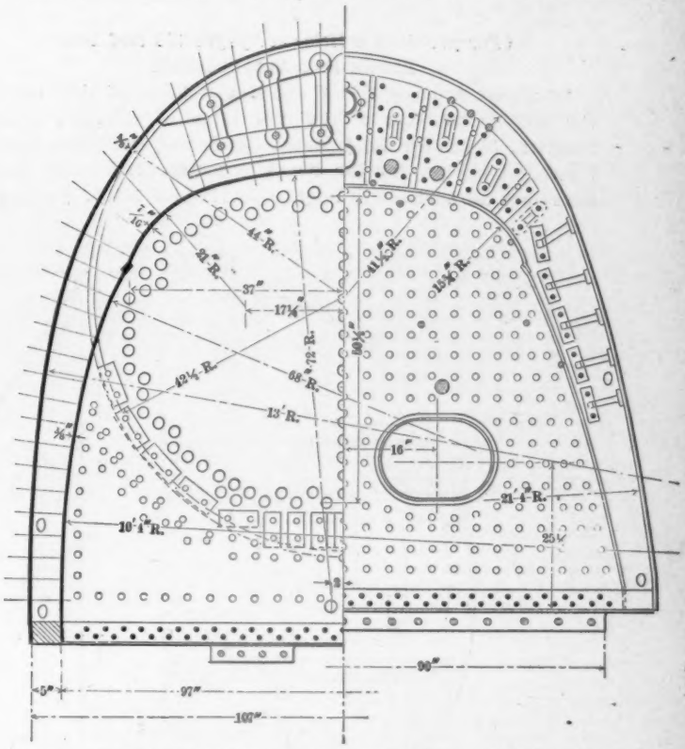
We wash out all boilers through the front flue sheet, hence the location of the apron extension of the deflector plate is important, hence I submit blue prints showing the moving of this apron from behind the exhaust pipe to a point in front of the same with hinge arrangement for adjustment and for throwing it entirely out of the way when washing out.

THE LARGEST LOCOMOTIVE BOILER.

MALLET ARTICULATED COMPOUND—BALTIMORE & OHIO RAILROAD.

The boiler of the remarkable Mallet compound locomotive, built by the American Locomotive Company for the Baltimore & Ohio Railroad, was illustrated from a photograph in May, 1904, page 167, and was again referred to in the general description in June last, page 237. The performance of this locomotive was described by Mr. Muhlfeld in our June number, 1905, page 229.

This boiler has a straight top and is 84 ins. in diameter outside the first ring, while the largest ring has a diameter of 88 ins. The firebox is 108 ins. long by 96 ins. wide, and the depth is 80 ins. in front and 72 ins. at the back. Water spaces of 6 ins. in front and 5 ins. at the back and sides are provided. There are 436 2¼-in. tubes, 21 ft. long, the tubes being No. 11 gauge. The heating surface is: Tubes, 5,366 sq. ft.; firebox, 219 sq. ft., making a total of 5,585 sq. ft., which is the largest



THE LARGEST LOCOMOTIVE BOILER—MALLET COMPOUND LOCOMOTIVE—BALTIMORE & OHIO RAILROAD.

ever employed in a locomotive boiler. The grate area is 72 sq. ft.

This boiler has thick plates. Those of the shell are 1 in. thick, the roof is ⅝-in., the front tube sheet ¾-in., the back head ⅞-in., and the throat sheet 1-in. The back tube sheet is ½-in. and the other firebox sheets 7/16-in. The boiler is 38 ft. 5 ins. long from the front end to the firebox door. It weighs, empty, and without tubes, 57,000 lbs., and complete, with water, 117,000 lbs. The water alone weighs 33,000 lbs., and the tubes alone, 27,000 lbs.

The drawing shows a large liner plate 1 in. thick on the inside of the bottom part of the shell at about the middle of its length. This is for the attachment of the saddle for the high-pressure cylinders. While this is an enormous boiler for an enormous locomotive, it is said to be easily fired by one man, but it is difficult to believe that one man can properly fire it in a pull of any considerable length. Here is certainly a fair field for the automatic stoker people to show what they can do.

As shown in the engraving, the throttle pipe connections are made at the sides of the dome, the passages to the throttle being cored in the cast-steel dome. The boiler has two firedoor openings, which are fitted with sliding doors. The injectors are on the back head and discharge through pipes leading well forward into the first shell course of the boiler. The center of

the boiler is 10 ft. above the tops of the rails, this being the greatest height of boiler in our record.

DIMENSIONS OF THE LARGEST LOCOMOTIVE BOILER.

Working pressure	235 lbs. per sq. in.
Diameter outside the first course	84 ins.
Distance between tube plates	20 ft. 10¾ ins.
Thickness of barrel and saddle sheets	1 in.
Thickness of tube sheet	¾ in.
Thickness of outside firebox and back lead	⅝ in.
Number of tubes	436
Diameter of tubes	2¼ ins.
Height of boiler centre above rail	10 ft.
Height of stack above rail	15 ft.
Firebox length (inside)	108⅛ ins.
Width (inside)	96¼ ins.
Thickness of tube sheet	½ in.
Thickness of crown sheet	7-16 in.
Thickness of side sheets	⅜ in.
Thickness of back sheet	⅝ in.
Grate area	72.2 sq. ft.
Heating surface, firebox	219 sq. ft.
Heating surface, tubes	5,366 sq. ft.
Heating surface, total	5,585 sq. ft.

COMMON STANDARD LOCOMOTIVES.

HARRIMAN LINES.

III.

(For previous articles see pages 154 and 200.)

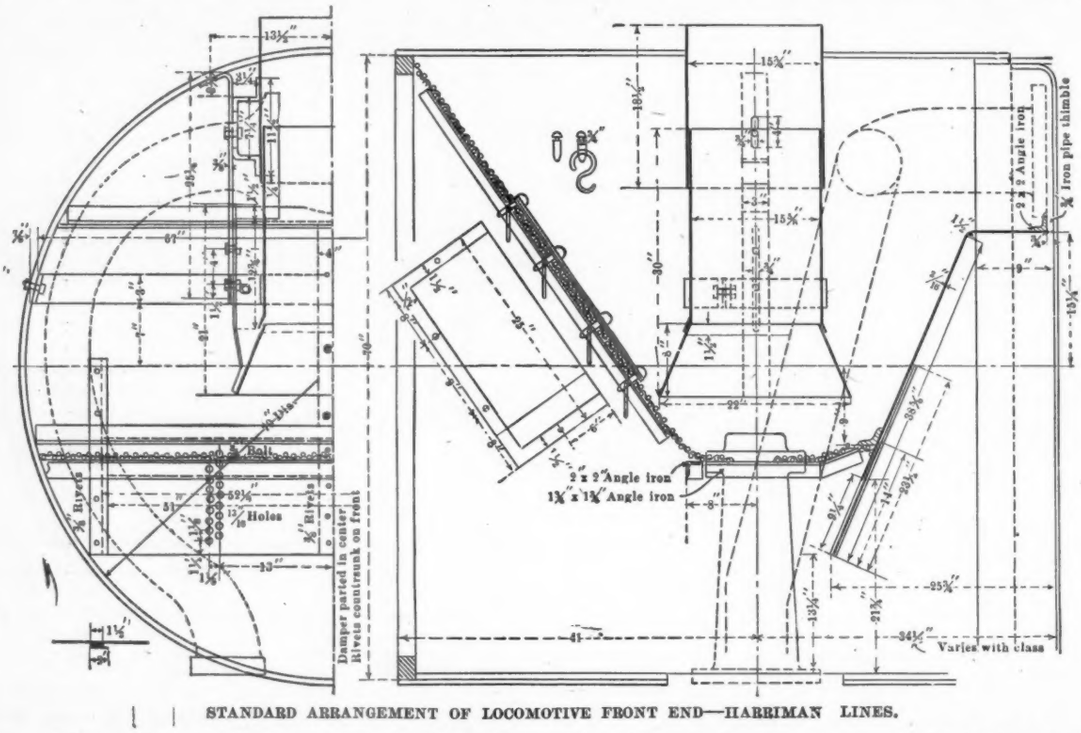
SMOKE BOX ARRANGEMENT.

As given on page 154 of the May number of this journal, the boiler diameters of the four types of standard locomotives are 70 ins. for the Atlantic, Pacific and switching locomotives and 80 ins. for the heavy consolidations. The smoke boxes are all sufficiently long to provide for cinder pockets in front of the cylinders and in fact all of the standard engines are fitted with them. The lengths of the smoke box rings are as follows: Atlantic, 71¼ ins.; Pacific, 91 9-16 ins.; consolidation, 69 9-16 ins.; switcher, 57½ ins. These will be illustrated later in connection with the boilers.

The arrangement of the smoke boxes is the same for all engines except as modified by the two diameters of boilers, the boiler of the consolidation type being larger than the others.

The same exhaust nozzle casting is used for all engines and the same size petticoat pipe with a 22-in. flare at the bottom. The diaphragm plate varies in size between the 70 and 80-in. boilers, but is arranged in the same way in both. This also applies to the netting. The distance between the center of the exhaust pipe and the front ring of the smoke box of the Atlantic and Pacific types is 41 ins., this distance on the consolidation is 46 ins. and on the switcher 38 ins. The distance from the center of the exhaust pipe and the front tube sheet varies necessarily in the different classes. It will be noticed that these petticoat pipes are all made in a single piece and are 15¾ ins. inside diameter.

We are indebted to Mr. W. V. S. Thorne, director of purchases of the Harriman Lines, for this information and to the Baldwin Locomotive Works for the drawings.



STANDARD ARRANGEMENT OF LOCOMOTIVE FRONT END—HARRIMAN LINES.

AMERICAN LOCOMOTIVE COMPANY TO BUILD AUTOMOBILES.—This company will build a plant at Providence, R. I., adjacent to the Rhode Island Locomotive Works, where, under the supervision of Mr. Haughton, the Berliet automobile is to be built, the American Locomotive Company having secured the exclusive right to manufacture these machines in this country. The initial output will be about 200 cars; the first machines to be 40 and 20 h.p. It is likely that the construction of automobile trucks for heavy service will follow.

ELECTRIC VS. STEAM TRACTION.—Mr. L. B. Stillwell, at a recent Institute traction dinner, said in regard to the Manhattan Elevated system: "Electrification of the elevated lines in New York has increased their capacity by one-third, and has decreased by one-fifth the time spent on trains by the average passenger. It has been demonstrated that the cost of maintenance of electrical equipment of rolling stock is materially less than steam equipment. It has proved that electricity can render more reliable service than steam, the aggregate delays due to all causes on the Manhattan lines now being less than one-half per car mile what they were when steam was used as a motive power.

RAILROAD MILEAGE OF THE WORLD.—According to figures printed in the *Archiv fur Eisenbahnwesen*, the total railroad mileage of the world at the end of the year 1903 was 531,659 miles. Europe has 186,566; Asia, 46,293; Africa, 15,549; Australia, 16,595, and America (North and South) has 268,655 miles.

COAL MINED IN 1904.—The production of coal in the United States in the year 1904 amounted to 351,196,953 tons of 2,000 lbs., of which 73,156,709 tons were Pennsylvania anthracite. During the past four years the amount of coal reclaimed annually from the culm banks by washing has amounted to about 2,500,000 tons.

MASTER MECHANICS' ASSOCIATION.

(*Other papers and abstracts of reports appear on page* 271.)

THE MECHANICAL STOKER—Opened by William Garstang.

The question of a scientific method of firing locomotive engines is not of recent origin. It has always been uppermost in the minds of the management of railways, as is evidenced by the fact that some companies have offered prizes of various kinds for the most efficient and economical firing, and this, too, in the day of the small engine, whose grate area did not exceed 30 sq. ft., with a maximum steam pressure of 180 lbs. If it was a question then, how much more important it must be to-day with 50 sq. ft. of grate area and a steam pressure of 200 lbs. or more.

Two hundred pounds of coal is an enormous quantity to burn per square foot of grate in an hour, but it can be done, and this would mean that with a grate having 30 sq. ft. of surface, the consumption of 3 tons an hour. This implies a shovel of coal every ten seconds, and we believe this is as much as the ordinary man can do. If we obtain, by compounding or superheating, more steam from 3 tons of coal, we have increased the capacity of the fireman, but who can say how long it will be before we must further increase the size of our engines and consequently the capacity of the fireman, the latter now admitted to be up to the limit.

Ten years ago the most of us thought the maximum size of locomotives had been reached, when a spurt followed and the locomotive grew rapidly. Has the limit yet been reached? The engine having grown to such proportions in the past ten years, it is pertinent to ask, has the fireman also grown in that time? Experience says "No." An engine with 50 sq. ft. of grate surface, burning 200 lbs. per hour per square foot, will consume 5 tons per hour, and if you get a fireman with sufficient physical endurance to handle 5 tons of coal per hour on an engine scheduled 45 (or 50) miles per hour, as they are to-day, he will very likely fall below the requisite in brain power, and, of course, be an inefficient fireman. This we all know from experience. So it seems our engines have passed the limit of human endurance in the matter of efficient firing.

A young man thinks he would like to fire a locomotive; he makes application for the job; he goes with the foreman to look over an engine, and the enormous size of the boiler fills him with dismay, and he goes into some other business. This means that the work on the big engines is more of brawn that of brain. Some will say: "That is all you need for a fireman." But where are our engineers to come from? Surely they must be men of "head," now more than ever, when speeds are high and trains are heavy. This employment of "coal heavers" for the left-hand side of the engine will surely be felt before long on the right-hand side, when promotions must be made.

They say: "Necessity is the mother of invention." It seems to have been so in this case. I presume some one, seeing farther ahead than most of us, thought: "Why won't an automatic stoker work as well on a locomotive as on a stationary boiler?" To think was to act, and we now have a practical mechanical fireman that is going to revolutionize the grade of men who enter the firing service and eventually become engineers. Instead of the "horny-handed son of toil," with a back like a horse, who must work like a coal heaver for ten or twelve hours continuously, we will have a set of men of greater intelligence—men whose heads will guide the stoker and control it—men who will not sit idly in the engine cab by any means, but who, though busy, will not be continually "frizzled" back of the open fire door, with their eyes blinded so that signals cannot be properly interpreted; but who, through intelligent operation of the stoker and careful watchfulness of the track and signals, and who coming in from a trip are not so tired out that they cannot study the rules and regulations and prepare themselves for advancement, will make a high grade of locomotive engineers when advanced to that position, and which will gradually mean a continuous elevation of both the men and the service.

Now, as to the stoker in actual service. It has been four years since the first mechanical stoker was tested on a Big Four engine. About six months ago we installed a mechanical stoker known as the "Victor," and same as the one on exhibition at the convention, on seven of the largest passenger engines on our system. Four of these engines have wide fireboxes and three have the long, narrow firebox. Both styles of firebox have been fired satisfactorily by the Victor mechanical stoker. From advices we receive from the division officers, we can safely say there is a noticeable saving in the amount of coal consumed per car and engine mile when operated with the stoker in comparison with hand firing, but at this time we are not prepared to state the exact per cent. of such saving. The same advices indicate a reduction of boiler work, on flues, staybolts and firebox seams, which, in our opinion, is due to the fact that we are enabled to carry a lighter, cleaner and more uniform fire, as well as uniform boiler pressure.

During the six months in which these stokers have been in service the cost of their maintenance has been very light. The principal cost of maintenance is largely due to improper lubrication. What few failures we have had with the stoker are due to the same cause.

In conclusion, I will say it is my opinion the mechanical stoker for locomotives has come to stay.

First—Because it is practical and efficient.

Second—We believe, by the adoption of the mechanical stoker the railway companies will be enabled to use a cheaper grade of coal than can be used in hand firing, resulting in a great reduction in their fuel bills.

Third—It will relieve the fireman of some of his most arduous labor and give him greater opportunity to observe signals while on duty, and he will arrive at the end of his run in condition to improve his chances by study for promotion to the position of engineer.

HIGH-SPEED STEEL—Opened by Mr. J. A. Carney.

The almost prohibitive cost of high-speed steel makes one consider carefully whether or not it should be purchased for all classes of work, and especially for old machines, which cannot tax the capacity of the cheaper self-hardening steels. When one figures that a tire lathe tool costs from $8 to $10, it looks like a lot of money. On the other hand, if we will take into consideration the slower speed, smaller output, time lost sharpening and dressing tools and the loss of material incident to dressing and sharpening, it will be seen that the cheaper tempering and self-hardening steels are too expensive to be considered. A case in question: A set of bolt cutter dies made of 10-cent tempering steel cost 21 cents for labor and 5 cents for material; total, 26 cents, and cut 100 bolts before dressing. A set of similar cutters made of 75-cent high-speed steel cost 37½ cents for material and 40 cents for labor; total cost, 77½ cents, and cut 1,100 bolts before dressing. Enough tempering steel cutters to do the same work would have cost $2.86. This is what I mean when it is said we cannot afford to use low capacity steel.

The use of tool holders and smaller sizes of steel will effect great economies in the investment of high-speed steel, and in one instance the introduction of tool holders reduced the number of pounds of steel required for a wheel lathe over 80 per cent., and instead of a tool 1 x 2 ins., 18 ins. long, costing $7.87, a 1 x 1 x 8-in. tool, costing $1.87, is used, and the tool holder does not wear out or break, and costs 5 cents per pound, against 75 cents per pound for high-speed steel.

Rosebit reamers can be tipped with high-speed steel and increase their efficiency from 750 to 1,000 per cent.; in fact, a little ingenuity and thought will open up economies in the quantity of high-speed steel that were never given a thought when 10-cent steel was used.

Larger section tools of high-speed steel which have become too short can be hammered out into tools of smaller section with excellent results.

High-speed steel has come to stay until some more efficient material is discovered, and while its price may make us question its economy, a second thought will convince us that we cannot afford to go back to the cheaper tool steels for heavy work, however good these may be in their class.

THE TECHNICAL EDUCATION OF RAILROAD EMPLOYEES.

ABSTRACT OF AN INDIVIDUAL PAPER BY G. M. BASFORD.

No other part of industrial development has shown such progress as that of transportation, and no other influence in human welfare is as vital as that exerted by the railroads. In connection with this progress and development, because of its radical character and great extent, the development of men has been allowed to take care of itself until it must be said that the most vital railroad problem of to-day is that of men.

The problem is that of men, the selection, preparation and training of men. If this is provided for the rest is easy. It is said to be less difficult to secure a new president than to secure a good shop or roundhouse foreman. This is, of course, not true, but it certainly is sufficiently difficult to obtain the necessary supply of foremen of the right sort and even more difficult to secure the right kind of men in the ranks. The men are not essentially different from those of a generation ago, but the conditions certainly are different. To improve conditions it is necessary to know what is wrong, and to know what is wrong it is necessary to understand the changes which the last few years have brought.

WHAT GROWTH HAS DONE.

A few years ago railroad mileage was in hundreds, whereas now it is in tens of thousands. The general manager once knew all of his subordinate officials, because they were few and changes were not frequent. He once knew all of his master mechanics, station agents, conductors, engineers, dispatchers and even telegraph operators. They knew him and were working for him because he was personally close to them in their work. All this has changed as the roads themselves became greater and as roads great in themselves combined into systems, as has never been done anywhere else in the world. With this change the officials have by a powerful current been carried far from the men in the ranks and far even from their subordinate officials. From personal friends, the men have become to them as mere numbers.

For example, we have one motive power official who is responsible for the service of more than forty thousand men. How many of them can he know? He does well to really know his chiefs of staff. From a simple business proposition, administration of railroads has become like the direction of the armies of a nation. But armies do not suffer weakness of organization because of increasing in size. An army becomes larger by aggregation of units, which of themselves become no larger. As size increases general officers are added. The commanding officer does not know all his men, but the captains do know theirs. From this standpoint the railroads need more captains, because the subordinate officials now know their men as little as the chiefs know their subordinate officers.

The recruiting and training is the same for a large as for a small army, because the units are of the same size. It is not so with railroads. For example, consider the organization of a new and large locomotive shop compared with a small one. This is one reason why the large shops of to-day are less efficient and less economical than the small ones. Shops have outgrown both men and methods.

THE RECRUITING OF THE PAST.

Considering shop forces, the recruiting of the past was through apprenticeship. It is not so to-day. One of the best equipped railroad boiler shops in the country has not a single apprentice and few of them have enough to be worth mentioning. Of twelve trades in one shop plant only three were found to have apprentices, but all had shop committees. In other departments apprenticeship

has been overlooked and neglected because there was so much else to do. There has been too much pressure to turn out work with existing facilities to admit of taking the necessary precautions concerning the men and the leaders of the future. The present demand for foremen with leadership talent and executive possibilities proves both the neglect of the apprentice and the distance which has grown between the officials and the men, for there certainly must be latent talent, dormant and undiscovered, sufficient for all necessities.

We need to be reminded that many men in the ranks are sure to rise in one way or another. If they are not encouraged in every possible way to qualify for higher positions on the staff they will employ their leadership in other directions, and here is an opportunity to reach one of the roots of the labor problem which has already been allowed to wait too long.

To-day telegraph operators, firemen, trainmen and others are usually taken from outside the service. They receive less preparation for their work than when there was less responsibility and less to do. The recruiting system is at fault, this being considered as unimportant. It is not so in England and in Europe, where the efficiency of the individual railroad employe is of the highest type.

Apprenticeship of the old kind was an ideal method of recruiting. Boys were carefully selected, conscientiously trained, and the employer exercised a moral as well as an educational influence over them. The present pace does not permit of such a system, yet the lack of it has brought a deplorable condition, and to take its place something is needed and that quickly.

A SERIOUS MISTAKE.

For twenty years the railroads have sought to provide the necessary leadership from the technical colleges and many strong officials have developed through what is known as the special apprentice system. It is perhaps possible to meet the immediate need in some such way; but when the technical school graduates come to the railroads, as outsiders, from the schools—as they usually do—this system is doing a fundamental injury, which is neither understood nor appreciated, but it is nevertheless serious. Every time a special apprentice is started on his course notice is, in effect, served upon the men and boys with whom he works, that he, because of his education, is to acquire in a few years sufficient knowledge, experience and ability to become one of the official staff. The effect in the shop is to discourage those who have not had such education. The special training of young men from without the ranks of the workers for official positions is fundamentally wrong, and, furthermore, it plays strongly into the hands of those who wish to see men leveled into classes, and considered as on uniform levels, as to the value of service. It may be necessary to continue special apprenticeship for a time. Technically educated men are needed and will be needed even more in the future, but they should come from the ranks and not from outside of the service. The present system, or any other system, which in any way serves to discourage the regular apprentices and thereby tends to cut off the source from which most of the successful men have come should give place to a system which will encourage all by making it possible for the lowest to become the highest in the briefest possible time. because the talent is needed now. Nothing adequately meeting the needs of American railroads has been accomplished either here or abroad. That such a system is possible and feasible can now be shown.

THE PLAN.

The suggestion is that recruits in shops (and this applies in principle, though not in detail, to other service) should be taken in as apprentices. They should be given shop training, which will increase their earning capacity to the utmost, and they should be placed under the direction of men of such character and moral influence as to lead them to form correct, broad and honest views of life and their proper relations with other men and their employers. Parallel with the shop training, attendance during working hours at a school provided and maintained by the road should be required; and for this a new kind of a school must be developed, as a new kind of apprenticeship must be developed—the kind that will meet the individual cases. They must not be dealt with in classes or by fixed rules. The school must be one wherein the shop and the studies go hand in hand. While the shop hours are taken for the school, home work should be rigidly required. Life must not be made too easy for the apprentices.

For example: Arithmetic is needed of the kind which will deal with pulleys, back gears, lead screws and other studies such as drafting and shop arithmetic, which will reveal the reasons for things seen and done in the shops. The school and the shop should be co-ordinate in every possible way. The local officials must be interested in and responsible for the boys in the school as well as in the shop. The higher department officials must be occasionally seen in the schoolroom and the foremen should be identified with it. An evening a month should be devoted to a general meeting of an apprentice organization, with an occasional stereopticon talk or lecture by a foreman or higher official. Here is an opportunity for the university extension idea. The boys should visit other shops in committees and report their observations for discussion. A library for books and periodicals is a necessary element. If the road has several shops a car should be equipped with valve motion models, sectioned locomotive apparatus and appliances, electric motors and generators and even a small stationary engine for the boys to study, dismantle, assemble and set the valves. The air brake cars have shown us how to use school cars.

As a part of the plan every roundhouse should have a comfortable reading-room provided by the company, with books, periodicals, charts and models. Every encouragement should be given the engineers and firemen to organize improvement clubs. The company should furnish stereopticons and occasional lecturers. Progressive education should accompany the present tendency toward progressive examinations. Here is another opportunity for university extension. Engineers and firemen should be educated to do their best, and it is important to bear in mind the fact that the difference between the work of the best and of the average man represents more to the road than the economies to be obtained from the best fuel-saving appliance or invention ever brought out.

An important opportunity for exerting a strong moral influence is available in this plan and an insight into the history of nations, political economy, the history of labor and the proper relations between employer and employe can be given. The scheme is not Utopian but practical, and the way is plain. The idea has been put by Milton P. Higgins in these words: "The object is to produce many well-trained and educated workmen, some foremen, and from the foremen a few superintendents." This structure represents a pyramid resting upon its base. As long as we seek the genius we stand the pyramid upon its apex and put it into a state of nervous equilibrium. "We may hope for much from a thousand educated, thinking expert American machinists, who have the skill, education and exact knowledge of the shops. Is not the production of one hundred well-educated workmen a more certain undertaking than the production of one genius?"

We are to-day looking for the genius and overlooking the good workmen, but by providing for many workmen we can not fail to find the necessary genius.

This school shop enterprise should be carried out for the individual, lifting each as high as he can go. It should leave the capable student prepared for a course in a technical school. An important part of the plan is a provision for sending, every year, a certain number of graduated apprentices to a technical school, for a short "sandwich" course, at the expense of the company. This should be held out as a prize or reward for high standing in the shop and school. This would provide technical men and they would be admirably prepared. Even if only one out of ten remains in the service the encouragement due to the possibility of securing such an education would affect every ambitious apprentice and every ambitious workman on the road.

With such a system the shop could probably in time supply all firemen, engineers and men for other service, in which the education, training and the *esprit de corps*, which would naturally be developed, would be most valuable. There is no reason why the traveling engineers should not co-operate with the teachers of the apprentice schools in the development of correspondence courses for engineers and firemen and the men would unquestionably respond, certainly as well as they do at present to the commercial correspondence schools. Having the shop schools, they may be taken to the student in every department by the correspondence method, whether he is on an engine, at a telegraph key, on the track or in an office. The development may be as broad as the need, and correspondence courses may be made a vital factor in the plan, and university extension an important element. Those who can not attend the schools must be provided for.

It seems possible that the future of the motive power officer and of his department, and of other officers as well, may become clearer and the outlook may be brighter when the needs are provided for in such a way. The word education, as distinguished from instruction, seems to represent what is needed, and it is clear that the education of managements and owners of railroads is the first step to be undertaken. If this is done there will be no problem too difficult to be solved, but if not there are many impossible of solution. Only in some such way as this can the officials get close to the men directly or indirectly.

No railroad with a constantly changing policy, or one on which the tenure of official life is uncertain, should for a moment seriously consider such a suggestion as is here outlined.

Shall this (or something better) be done? The writer believes that the future, not only of the motive power officer, but of the railroads, and to a large extent of the country, depends on the answer.

There is no need of worrying about the college man: he is fully capable of taking care of himself, and it will be really a favor to him to put him entirely upon his own resources. He should not be handicapped by being labeled, because of his education. Special provision in the shops for the graduate of a technical college should not be made. Employers should not modify their methods for him. To do so is not advantageous to the college man, or to the other men in the shops.

The condition and position of the superintendent of motive power should be elevated and improved, so that young men will see that they can afford to spend their lives preparing for the highest positions. They will then be impressed with the fact that to secure such a position is worth a lifetime of conscientious and unwavering effort. This is not the case to-day.

CONCLUSION.

For the men and officials of the future, technical education is required, but it must be obtained while the student otherwise prepares himself for his work. It must go hand in hand with his education in the service, and the education must be arranged especially to suit his needs. For the engineering education he must not be required to fit himself to existing schools. A new school must be developed specially for him. Instead of giving years to subjects which are merely good for mental training, he must give months to those which he will remember. Moreover, he must not separate himself from active work and responsibility for long periods in order to attend school.

An adaptation of the Admiralty and Drummond plans would seem to fit American railroad conditions. These developed naturally, quietly and effectively. They are the work of broad-minded men. When the men who are making American railroads interest themselves in the problem an even greater plan will be forthcoming. They should not delay, for the need is imperative.

Are we a nation so enveloped in a cloak of progress that we cannot see the future?

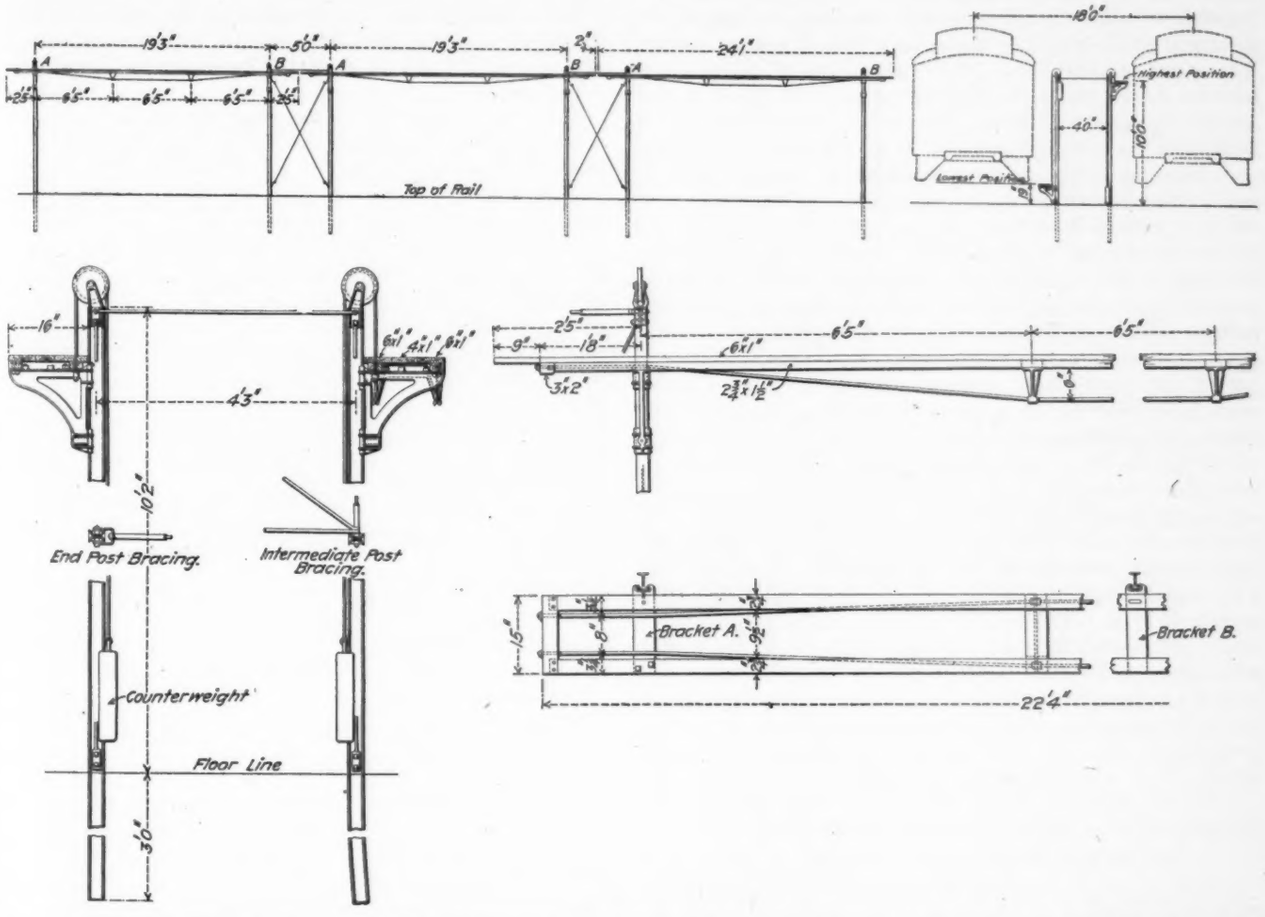
ADJUSTABLE SCAFFOLDING FOR PASSENGER CAR PAINT SHOPS.

The adjustable scaffolding for passenger car paint shops, illustrated on the accompanying drawings, is in use at the Collinwood shops of the Lake Shore & Michigan Southern Railway and is notable because of its simplicity and the ease with which the platforms can be moved up or down. These afford ready access to any portion of the outsides of the cars, as they may be easily adjusted from their lowest position of 19 ins. above the floor level to the highest position of 10 ft. above. The platforms are carefully counterweighted and thus move up and down with ease.

by merely lifting it up or down, the counterweight holding it in the desired direction. The smaller detail view appearing in the drawing of the scaffold indicates the relative locations of the platforms between the cars upon the tracks and also the clearances.

WHAT A FEW MODERN MACHINES WILL DO.

The following figures are from a road, the name of which must be withheld for the present. Several years ago a new era in its motive power department was inaugurated, and the results are indicated in the accompanying table, which includes the number of locomotives added to the equipment



ARRANGEMENT AND DETAILS OF ADJUSTABLE SCAFFOLDING FOR PASSENGER CAR PAINT SHOP.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

The posts which support this system of scaffolding consist of 6-in. I-beams, arranged in double rows, 4 ft. 3 ins. apart, between each row of tracks in the paint shop. The posts are set 3 ft. below the floor in concrete, extending 10 ft. 2 ins. above, and are carefully braced laterally by tie-rods, connecting their tops. Between sections of the platforms, where four posts are grouped together, both lateral and diagonal, and longitudinal bracing are resorted to in order to stiffen the entire structure. The posts between the wall of the building and the track nearest it are similarly braced from the wall.

The platforms are carried upon cast-iron brackets of special construction, having special grooved guides at the rear so as to slide up and down the flanged portion of the I-beam, as shown in the drawing of the scaffold. The platform consists of three planks, 24 ft. long, carefully trussed, as shown, making a substantial walk-way 16 ins. wide. This is flexibly carried upon the iron brackets to allow for inequalities of height of the two ends. The weight coming upon the bracket is supported directly by a cable, passing over the pulley at the top of the I-beam, to the counterweight at the rear, as shown. The height of the platform is readily changed

in four years, the increase in the aggregate tractive power and the advance in the shop output.

With an increase of 40 per cent. in the number of locomotives, an increase of 75.8 per cent. in the aggregate tractive power, there has been an increase of 80 per cent. in the number of locomotives repaired in the shops over the number repaired in the year 1900. According to the official who supplied this information, "the only increase in facilities that we have had to accomplish these results has been the installation of a few modern machine tools, and using some of the stalls in each of our roundhouses at the main terminals for erecting shop purposes."

ENGINES REPAIRED AND ENGINES IN SERVICE.

ENGINES IN SERVICE.

	1900	1901	1902	1903	1904	% Inc. over 1900.
Number of Engines.	375	403	428	453	525	40.0%
Tractive Power.	8,588,971	9,708,026	9,794,728	9,932,856	15,100,425	75.8%

ENGINES REPAIRED.

Total	263	267	295	439	473	80.0%
Av. Per Month	22	22	25	39	40	81.7%

REPORT OFCOMMITTEE ON FREIGHT EQUIPMENT.

ROCK ISLAND COMPANY.

III.

(*For previous article see page* 206.)

DESIGNS FOR NEW EQUIPMENT.

The freight equipment of the future should be designed with a view to withstanding the shocks incident to the use of much heavier locomotives and longer trains of higher capacity units than in the past. The committee believes that the practical and economical limit of strength of the wooden car has already been reached with the motive power now in use on the systems, and therefore recommends that steel be used to the largest practical extent in the construction of new equipment.

It is recommended that commercial sizes of rolled plates and shapes only be employed, such as can be purchased in competition in the open market. The use of pressed steel shapes is not considered desirable, owing to the fact that the material cannot be distributed to the best advantage, and that for repairs either expensive machines and dies must be provided, or the parts must be obtained from the manufacturers at the risk of considerable loss of time. The designs have been worked out with a view to using only commercial shapes, in such a manner that they may require only punching and shearing, without the necessity for heating and working in forms or dies. Cars of this construction may be readily repaired at any of the shops of the systems, without any special equipment, aside possibly from pneumatic riveting hammers and cranes for handling floor frames.

The use of steel underframes only, with wooden superstructures is not advocated, from the fact that the steel does not change in size from shrinkage while the woodwork does, therefore the rods and bolts become loose and the whole superstructure becomes shaky and deformed.

The designs contemplate the use of a steel underframe with a steel skeleton superstructure, rigidly secured to the underframe, and braced in such a manner as to retain its normal shape under all ordinary conditions. All closed cars should have floor, lining, sheathing and roofing of wood secured to nailing strips bolted to the steel frame. Coal and hopper cars should have floor, sides and ends of wood secured to the steel frame, it being considered more economical to maintain cars built in this way than those constructed wholly of steel. The dimensions of the cars recommended are as follows:

RECOMMENDATIONS AS TO STANDARD CARS.

BOX CARS.

Length over end sills	37 ft. 8 ins.
Width over side sills	8 ft. 7¾ ins.
Clear inside space	36 ft. 7 ins. x 8 ft. 6 ins. x 8 ft.

FRUIT CARS.

Length over end sills	37 ft. 8 ins.
Width over side sills	8 ft. 7¾ ins.
Clear inside space	36 ft. 7 ins. x 8 ft. 6 ins. x 8 ft.

STOCK CARS.

Length over end sills	37 ft. 8 ins.
Width over side sills	9 ft.
Clear inside space	36 ft. 7 ins. x 8 ft. x 7 ft.

FURNITURE CARS.

Length over end sills	41 ft. 1 in.
Width over side sills	9 ft. 1¾ ins.
Clear inside space	40 ft. x 9 ft. x 10 ft.
Length over end sills	51 ft. 1 in.
Width over side sills	9 ft.
Clear inside space	50 ft. x 8 ft. 10¼ ins. x 9 ft. 9 ins.

REFRIGERATOR CARS.

Length over end sills	41 ft. 1 in.
Width over side sills	9 ft. 1¾ ins.
Clear inside space between tanks	33 ft. 6 ins. x 8 ft. 3 ins. x 7 ft. 6 ins.

GONDOLA CARS.

Length over end sills	41 ft. 1 in.
Width over side sills	9 ft.
Height over side planks	4 ft.
Clear inside space	40 ft. x 8 ft. 8½ ins. x 4 ft.

FLAT CARS.

Length over end sills	41 ft. 1 in.
Width over side sills	9 ft.

HOPPER CARS.

Length over end sills	34 ft.
Width over side sills	9 ft. 6 ins.
Height from top of rails to top of sides	10 ft.

Owing to traffic requirements, it is not possible to use a single standard for floor framing for all classes of cars, and the committee does not understand that the benefits, from a maintenance standpoint, would offset the expense of hauling the extra dead weight that would be imposed upon some classes by the use of a single standard.

The lengths and widths recommended are based upon traffic requirements as nearly as possible, and call for longitudinal members of but two lengths and transverse members of but three lengths for all classes except the hopper cars, which, necessarily, are in a class by themselves.

The center sills and draft rigging should be of uniform strength for all classes, as the strains imposed in service are not related to the carrying capacity, trains being made up of cars of all descriptions and a low capacity car may be placed between a number of high capacity cars.

The capacity recommended is 60,000 lbs. for all classes except gondola and flat cars, which are to be 80,000 lbs., and hopper or other types of self-clearing cars, which are to be 100,000 lbs. There will, therefore, be but three capacities of trucks required, all being of the same general types and of as few parts as possible.

The committee desires to state that cars of the same general construction as those shown by these designs have given very satisfactory results in service on a number of roads, hence they feel that the foregoing recommendations are in the line of actual practice rather than of theory.

The committee also desires to call attention to the recently introduced type of self-clearing gondola cars, which have flat floors from end to end, the floors being composed wholly of doors, which when dropped discharges the entire load without shoveling. As the floors are flat, the cars are available for all classes of traffic for which an ordinary gondola car can be used, as well as for construction purposes, and it is thought that this type might be a valuable addition to the equipment. Such cars may be built with steel framing in the same manner as the design recommended.

HECTOGRAPH FORMULA.

A reader recently asked for a formula for making hectograph pads, and through the courtesy of Mr. H. E. Smith, chemist and engineer of tests of the L. S. & M. S. Ry., we were enabled to furnish the following information:

Clear hide glue, 1 lb.

Water, 1½ pts.

Glycerine, 2½ pts.

The glue should be of a good quality, and the kind that comes in transparent, light-brown sheets, as the white or brown opaque glue does not give as good results. Break the glue into small pieces and soak it in the water over night in a covered vessel. Then melt it in a water bath, and add the glycerine, which should previously be heated to the same temperature as the melted glue. Stir only as much as is necessary to mix the glue and the glycerine, as too much stirring introduces air bubbles, which are difficult to remove. Pour the hot mixture through a cheese cloth bag into the pans. When the pans are filled and the jelly is still quite fluid, sweep off air bubbles or impurities from the surface with the edge of a card. Let the pans stand 48 hours before using. This formula calls for much less water than usually required by other formulas, since it is preferred to secure the requisite softness by means of the glycerine, which does not evaporate and allow the pads to dry out and harden, as does the water.

In writing the original copy always use hard, glazed paper and write with hectograph ink. In making the negative moisten the surface of the pad with a cold wet sponge, wiping off the excess of moisture. Dry off with a newspaper, and let it stand for two minutes. Place the original face down on the pad for from one to three minutes, rubbing down to a perfect contact, and then carefully remove. In printing apply a clean sheet of any kind of paper so that it touches the hectograph at all points, rubbing as little as possible. Never use hot water for removing the negative; as soon as the copies are all made, wash off with a sponge and cold water and dry off well with a newspaper. Never let the pad stand with ink in it after the copies are made, and always keep it closed when not in use.

IMPRESSIONS OF FOREIGN RAILWAY PRACTICE.

EDITORIAL CORRESPONDENCE.

BERLIN.

One reason for the relative lightness and comparatively small heating surface of German locomotives is the limitation of weight allowed per axle. In continental practice designers are limited to loads of from 14 to 16 tons per axle and because of these limits it has been necessary to avoid all unnecessary weight. While this limits the power of the locomotives it has not been altogether detrimental because the Germans have been obliged to utilize the weight to the best possible advantage. This has resulted in a refinement of design in the matter of detail parts which is admirable and has already been mentioned in these letters. I should say that it will be impossible to remove an ounce of metal from the main rod of a German passenger engine or from any part of the valve gear, yet these parts never seem to break or give anything like the trouble we have with much larger parts. The advent of the superheater in German locomotive practice doubtless resulted from a desire to increase the boiler capacity without extending the limits imposed upon weight. These restrictions therefore have proved beneficial to the locomotive world in general.

German practice of about 10 years ago employed from 1,400 to 1,500 sq. ft. of heating surface and about 26 sq. ft. of grate area, giving a ratio of from 1 to 55, or 1 to 60. The present tendency is to increase the heating surface to a little more than 1 to 60. The Baden State railways use a little over 2,100 sq. ft. of heating surface in a ratio of 1 to 60. The Prussian State railways were late in advancing in the matter of capacity; the trains are now limited to 40 axles, and will soon be permitted to reach 44. With 40 axles and 10 cars the maximum trains weigh about 350 tons. The statutory speed limits are 62 miles per hour, but because of the Berlin Zossen high-speed experiments, the limit of speed is likely to be increased. Boiler forcing is not popular in Germany, and an output of one h.p. for two sq. ft. of heating surface is considered to be questionable forcing. A speed of 55 miles per hour with 350 tons on level track is considered excellent work in Germany. One of the Atlantic type locomotives of the Baden State railways, which is the heaviest passenger locomotive in Germany, has maintained an evaporation of 13.2 lbs. of water per sq. ft. of heating surface per hour, and kept this up steadily for an hour. This work required 90 lbs. of coal per sq. ft. of grate per hour, with an evaporation of 7½ lbs. of water per pound of coal, and required a smokebox vacuum of 5 ins. This locomotive weighs 74 tons.

The Germans adjust draft in the front end with a blast pipe, raising the pipe to draw the front end of the fire and lowering it to draw the back end. They do not use our diaphragm plates. Professor von Borries finds that 50 per cent. more draft is required if the diaphragm plate is used, and in this he agrees with the results of the AMERICAN ENGINEER tests on locomotive front ends.

Prof. von Borries has had a great deal of experience with two-cylinder as well as four-cylinder compounds, and opinions expressed in his article in this journal in May are exceedingly valuable. He does not consider four-cylinder compounds more economical than two-cylinder compounds, but does find them more economical in repairing. The four-cylinder arrangement prevents the knocking of boxes, and the stresses are equalized by the four cylinders, which reduces weaving and working of the frames and everything else between the driving boxes and the cylinders. He has gone very thoroughly into the subject of balancing the four-cylinder compounds, studying the subject by the aid of an elaborate model. He does not bother to balance the reciprocating parts, and prefers coupling all four cylinders to one axle, because the stresses in the axle tend to neutralize each other, and he finds that this arrangement produces smaller stresses in the axle than in the case of the engine which is divided with the outside cylinder coupled to the rear driving wheels. He also prefers his arrangement because of accessibility and less complication. His remarks on valve gear, cut-off and cylinder ratios in his article for this journal are specially worthy of note.

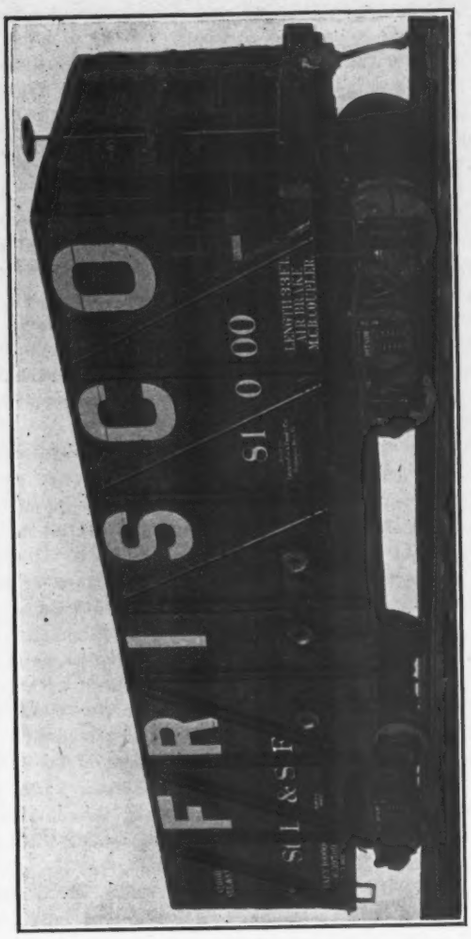
We would consider the boilers of German engines very small; however, a 74-ton engine which will haul a 300-ton train 68 miles in an hour is certainly doing excellent work. Prof. von Borries insists upon brick arches, and he aims to secure air admission, through the grate, amounting to one-third of the grate area; he does not, however, attain this figure. Walschaert valve gear and modifications of it are the rule in Germany. It is used so generally because of a theoretical constant lead, the long valve travel, uniform distribution of steam and the directness of the connections. While the inside motion is preferred because it is protected from dirt, and is out of danger of being hit, the gear is not by any means confined to the inside construction. Men in charge of maintenance, however, greatly prefer the outside arrangement because of its accessibility.

Superheating in Germany requires specially careful treatment in order to represent it properly. It is always necessary to use extreme care in estimating the value of such a principle, because of the tendency to place its claims in the most favorable light possible. For this reason I did not form my opinion until after I had talked with a number of cool-headed railroad men, who could not be accused of being too enthusiastic on this subject. Superheating in Germany has established itself because the principle is accepted as good. It has made an excellent record in freight as well as passenger service. The steam is remarkably quick in its action, and care is required to prevent pounding of the boxes in fast engines. Because of the rapidity of the movement of the steam through the pipes and passages 6-in. piston valves are the rule, and our 15-in. piston valves at home look absurdly large in comparison. The liveliness of superheated steam is, I believe, one of the important advantages of this principle, which has not yet attracted sufficient attention. Especially because the boiler of the superheater locomotive is always ready for a wide range of work and speed, superheating has made a very fine record in freight service. For very fast service, however, the compound has made a better showing against the superheater than in slower service. I find everywhere a rather strong tendency towards the belief that a combination of compounding and superheating gives the best possible records, but for my part I cannot see the necessity for compounding if the superheating is sufficient to maintain dry steam at all times.

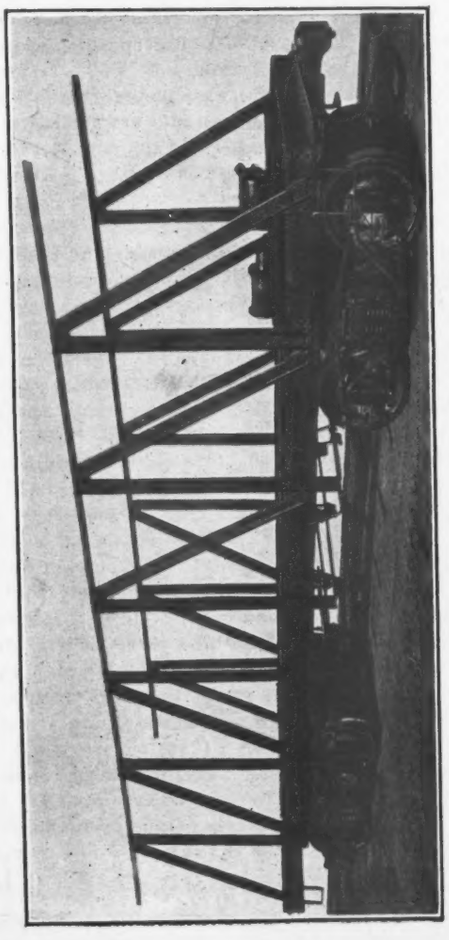
As to valves, I was told of an experiment showing a leakage of 3,300 lbs. of steam per hour through a plug piston valve while a plain piston valve with rings did not leak more than 440 lbs. of steam in the same time. In the first case 20 per cent. of the power of the engine was lost through the leakage. It is possible that this plug valve was not properly fitted, but if piston valves with rings work so satisfactorily in connection with superheating in the United States, we need not hamper superheating with leaky plug valves without rings. Superheating has certainly had the advantage of influential advocates in German practice, otherwise in such a short time it would have been impossible to introduce over 100 superheater locomotives into this service in such a conservative country. While economy is an item of great importance in Germany, because of the cost of coal, the argument of increased boiler capacity provided through the superheaters is a more important one. The Germans do not like large boilers, or high boiler pressure, and high superheating is advocated on these grounds and also because of a desire to reduce the amount of double-heading, which has become necessary in freight surface. Superheating in Germany is not in any sense a fad. It was taken up for good and sufficient reasons, and I am sure it has come to stay. Before these paragraphs are printed I am sure that we shall have nearly as many superheater locomotives running in the United States as are now running in Germany.

G. M. B.

(To be concluded.)

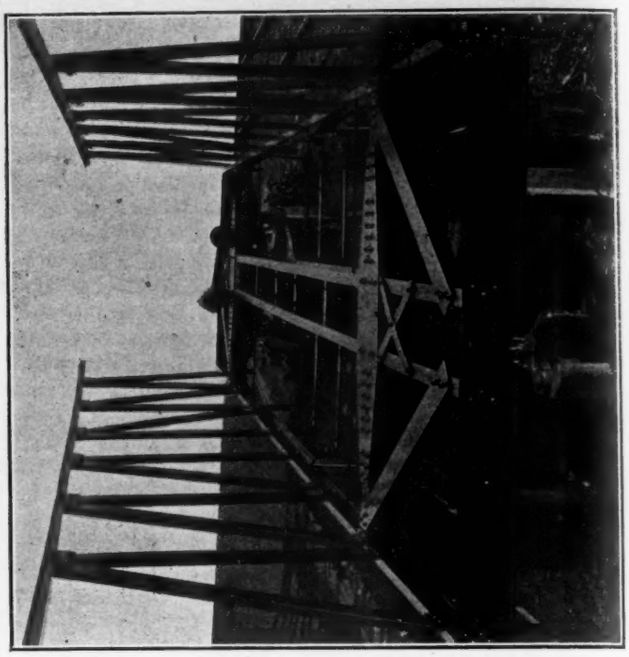


GENERAL SIDE AND END VIEWS.



SHOWING CONSTRUCTION OF SIDE FRAMING.

50-TON COMPOSITE COAL CAR.—FRISCO SYSTEM.



END VIEW SHOWING SIDE AND BODY FRAMING.

50-TON COMPOSITE COAL CAR.

FRISCO SYSTEM.

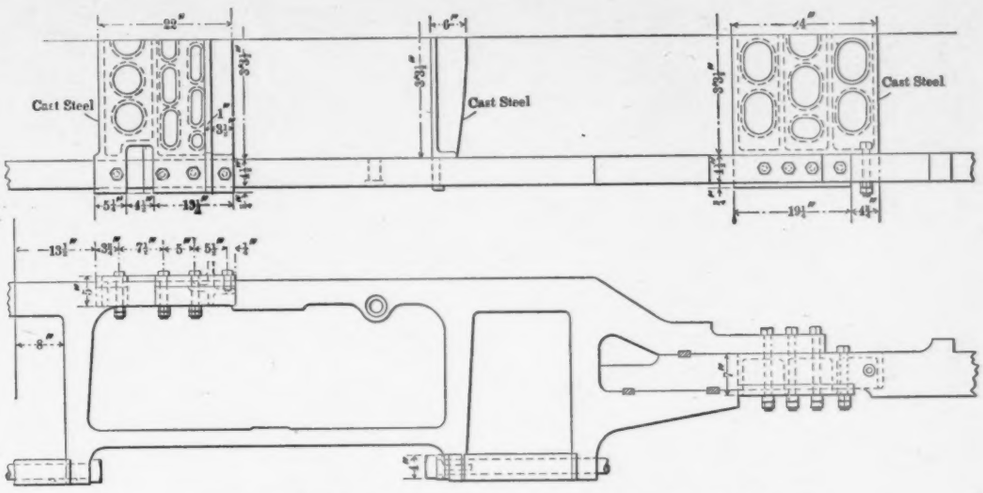
Drawings and photographs have been received from Mr. W. A. Nettleton, general superintendent of motive power of the Frisco System, illustrating the 50-ton hopper coal cars built for that road by the American Car & Foundry Company. The general design of this car is similar to the Norfolk & Western car of the same type, illustrated in this journal in February, 1901, page 43, and referred to in the article in the June issue describing the latest Seaboard Air Line car. The trucks of the Frisco car are of the standard arch bar type on that road for cars of 50 tons capacity. These trucks have Simplex bolsters, Symington oil boxes, inside hung brakes, Simplex brake gear and Miner draft gear. The photographs show the end framing and side framing.

The general dimensions of the Frisco car are:

Length inside	30 ft. 9 ins.
Length over end sills	33 ft. ½ in.
Width inside	8 ft. 9½ ins.
Width over sides	9 ft. 2 ins.
Height inside	7 ft. 11 ins.
Height over brake staff	10 ft. 6⅛ ins.
Capacity in cubic feet	1,583
Capacity in lbs.	10,000
Weight	39,000 lbs.

EFFECT OF OIL IN BOILERS.—The temperature of steam at 200 lbs. is 380 deg.; the temperature at which steel commences to lose its tensile strength is 650 deg., and at 1,200 deg. about 75 per cent. of its original strength has disappeared. If the surface of a furnace in a boiler for, say 200 lbs. pressure, were clean, the temperature of the metal would never reach the point at which its original tensile strength would be appreciably reduced, even under very high rates of evaporation. If, however, the surface were simply rubbed over with a very thin coating of mineral oil, the temperature would at once rise to over 650 deg., even with a moderate rate of evaporation.—*D. B. Morison, before Northeast Coast Institution of Engineers and Shipbuilders.*

NEW ENGLISH BALANCED COMPOUND.—Mr. H. A. Ivatt, of the Great Northern (England), has designed and built a four-cylinder balanced compound, 4—4—2 type, passenger locomotive, weighing 69 tons. It has 13 and 26 by 26-in. cylinders, the high-pressure being coupled to the rear and the inside, low-pressure coupled to the forward axle. The principle is similar to that of Von Borries, with Walschaert valve gear.



APPLICATION OF FRAME BRACES.—MICHIGAN CENTRAL RAILROAD.

LOCOMOTIVE FRAME BRACING.

With the increasing capacity of locomotives a general difficulty has arisen in the breaking of frames. Mr. E. D. Bronner, superintendent of motive power of the Michigan Central Railroad, has made a careful study of this subject and has supplied information concerning remedies which have been applied with notable success. A number of frames of 21 x 26 in. 4-4-2 type locomotives had broken at the front splice. After studying the breakages and investigating the "working" of the frames by riding on the running boards, rendering it possible to closely observe the frames when the engines were working, the conclusion was reached that the stresses leading to breakage might be distributed by tying the frames together across the engine. Of six locomotives of this type five broke their frames before the bracing was applied; the sixth locomotive was fitted with braces after it had been in service about six months and the frames have not broken since. It seems reasonable to suppose that the bracing accounts for this result. The accompanying engraving illustrates the braces and their application. It appears that the bracing transfers considerable stresses, because a number of the brace bolts have been found broken in service.

In connection with this study of frames it has been noted that forged frames after being broken and repaired have given no further trouble. This seems to be due to the fact that when repaired by welding the parts are never restored to exactly the original length, and this apparently indicates the existence of excessive internal stresses in the frame structure caused by forging it into shape. In many instances side bolted patches have been applied very successfully. The amount of flexure of the frames noticed in this investigation has surprised those who watched it as the locomotives were working hard, although no attempts were made to measure it, as was done in the interesting tests on the Lake Shore, which were illustrated and described on page 8 of our January, 1904, issue.

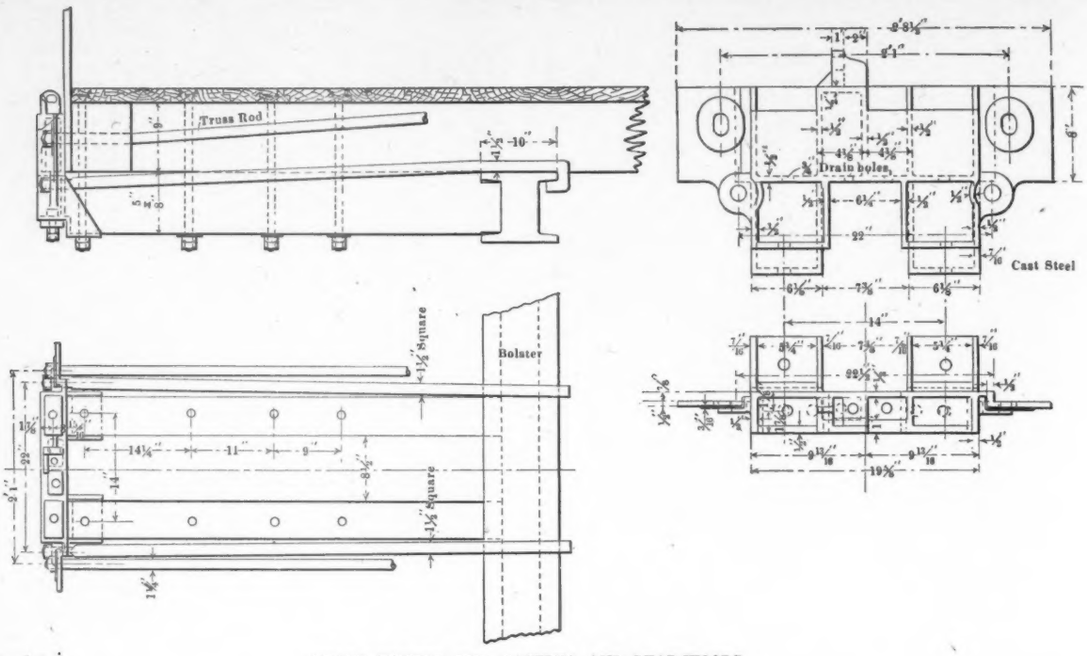
NEW YORK SUBWAY SIGNALS.—A record of one failure to 323,594 signal operations for an entirely new equipment of signals is worthy of note. These figures are given by Mr. J. M. Waldron in a paper before the Railway Signal Association, describing the New York Subway signals. The track circuits work with alternating current over the rails, which carry the return currents from the motors of the train, the relays responding to the alternating, but not to the direct current. For the month of February there were but three failures on account of the alternating current for 4,206,720 signal movements. The interlocking plant at 96th street handles 115 trains each hour during the rush periods.

RESULTS OF WATER PURIFICATION.

On the Buffalo division of the D., L. & W., 70 miles east of Buffalo, at Groveland Station, there is a grade 60 ft. per mile, 14 miles long, upon which we use pusher engines to help freight trains. At the foot of this grade we have an engine house and coaling and water station. We operate from this station from six to eight pusher engines the year around. The water there was the poorest on the division, and we were bothered seriously with leaky boilers, especially with tubes. On account of the continued trouble from leaking, the engines were out of service a great deal of the time. It was necessary to wash the boilers twice every week. In November, 1902, we put in a water purifying plant, and have received excellent results from the use of the treated water. To determine just what we could expect in the way of better results from our pusher engines there, we ran a test with a consolidation engine.

We found by referring to our books that this engine wore out 307 tubes between January 1, 1902, and January 1, 1903. During that time it had made 31,442 miles, an average of 103 miles to the life of each tube. The engine was taken to the shop January 1, 1903, and given a full set of tubes (207), and the test on the treated water was conducted from January, 1903, to October 17, 1903. During the 10½ months the engine made 39,044 miles, or 188 miles per tube, and the tubes were still in fair condition up to that time, which showed a gain of 82.5 per cent. per tube. During the period of comparison—1902-03—the engine made in 11 months an average of 2,858 miles per month. From January, 1903, to October 17, 1903 (during the test), the engine made 3,718 miles per month, an increase of 30 per cent. in mileage, for which the treated water can be given credit. When we took the engine into the shops for resetting of tubes, we made a careful inspection of the interior of her boiler, and came to the conclusion that there was about 75 per cent. less sediment on the tubes and boiler shell than we had been in the habit of finding in the same boiler for a similar period of service. I think it would be fair to estimate that we saved at least 5 per cent. in fuel, due to less scale on the heating surfaces.—*F. W. Williams, before Master Boilermakers' Association.*

MANUFACTURING AT REPAIR POINTS.—In a paper read before the Central Railway Club, Mr. W. F. Jones, general storekeeper of the New York Central, takes the position that material should not be manufactured at repair points because of the inferior character of the facilities usually supplied at small repair shops. He believes that manufacturing of repair parts should be concentrated at large shops, where the best facilities are available.



DRAFT TIMBER END CASTING AND DEAD-WOODS.

DRAFT TIMBER END CASTING AND DEAD WOODS.

ST. LOUIS SOUTHWESTERN RAILWAY.

A combination of draft timber end casting and "dead-woods" in a single steel casting has been developed and applied by Mr. T. E. Adams, general master mechanic of this road, for application to wooden cars. Its purpose is to reduce the number of parts, and support the draft timbers in such a way as to reduce the breakage of draft timber bolts. This construction dispenses with chafing irons, chafing iron bolts, dead-woods and dead-wood plates. It protects the draft timbers from damage in case the followers break and the coupler is driven back. It distributes the stresses on all the sills through the bolster, and relieves the draft timbers of tensile stresses. It is impossible to break the draft timber bolts unless this steel casting breaks or the squared rods leading to the bolster give way. In new cars the ordinary dead-woods may be dispensed with, and this construction may be used on any class of cars, being specially desirable in connection with metal bolsters. In the drawing the large casting has a lug, providing a bearing for the coupler unlocking rod. These drawings were received from Mr. Adams, by whom the device has been patented.

SAND HOUSES.—BALTIMORE & OHIO RAILROAD.

The Baltimore & Ohio Railroad has as its standard design a sand house apparatus that has proven most successful and the best arrangement for handling and drying sand for locomotive use. This arrangement of sand house has been applied to quite a number of the recently constructed roundhouse terminals and coaling stations at Brunswick, Md., Cumberland, Md., Keyser, W. Va., Fairmont, W. Va., Holloway, Ohio, and Glenwood, Pa., New Castle Junction, Pa., etc.

By it the wet sand storage is placed at the head end of the coaling trestle and the cars containing the wet sand are placed over the storage bin and the sand discharged from self-dumping cars. The wet sand storage bins have a capacity of 70 car loads, or 2,100 tons.

The sand drying room is located in the center of the wet sand storage bin and as the wet sand is stored on a level with or above the eaves of the roof of the drying room, it is conducted into the hopper of the sand stoves by gravity. When the amount of sand in storage comes below the roof of the drying room the sand is then shoveled into the stove hoppers.

When any part of the sand in the stove hoppers becomes burnt and thoroughly dry it flows through the meshes of the netting and falls to the floor onto the dry sand hopper, from which it is conveyed to the sand tank by gravity. After the dry sand tank is filled the application of about 50 lbs. of air pressure closes the sand inlet valve and automatically forces the dry sand upward into the dry sand storage bin, from which it is conveyed by a suitable arrangement of valves and spouts into the sand boxes on the locomotives.

A FLOOD OF ENGINEERS.—A proportion of 15,000 students in American engineering colleges to a total of 40,000 engineers employed in the United States and an influx of 4,000 graduates annually with only 2,000 required annually to keep up the supply, forms the basis of an admirable discussion of technical education in *Engineering News*. This article shows that the number graduated from law and medical schools is not more than is required to keep pace with the natural annual growth and the conclusion is drawn that at the present rate competition between engineers will increase as a matter of self-preservation. *Engineering News* urges for engineering students more attention to commercial, cost keeping and administrative studies, so that engineers may be in position to operate the machinery produced by engineers, in which the railways are included. Among other important suggestions, this article presents the following: "In spots here and there we see evidences that the engineer has taken hold of the machinery that he has planned and is operating it. The future holds its greatest rewards in store for those engineers who are the first to seize upon the directing of the forces that are now in the hands of untrained men." In the past the man who has come up from the ranks has built the railway and another man equally self-made has operated it. The opportunity for the engineer is to apply his talents in its operation.

STEEL CARS FOR STREET SERVICE.—Following the lead of the Interborough Rapid Transit in the equipment for the New York Subway, the New York City Railway is making a trial of a street car constructed of steel. An experimental car built by the Pressed Steel Car Company made a trial trip June 5th with Mr. H. H. Vreeland and officials of the railway, accompanied by Mr. F. N. Hoffstot, president of the Pressed Steel Car Company. An interesting development of street cars built of steel may be expected to result from this experiment.

COMMUNICATIONS.

BELPAIRE BOILERS.

To the Editor:

One who has watched the development of European locomotives cannot fail to be impressed with the rapidly increasing use of the Belpaire fire-box. It is used on nearly all recent French locomotives, or perhaps half of the latest English engines, and on much of the modern equipment of the Prussian and Netherlands state railways. The construction of this fire-box provides excellent flexibility to take care of unequal expansion, while the radially-stayed boiler resists such expansion with almost perfect rigidity. The crown stays can be inserted perpendicularly into both sheets, and the form of the outside, or wrapper, sheet is such that it is not altered by internal pressure, while it is well known that the shape of the radially-stayed boiler is altered by the pressure, to the injury of the sheets and, perhaps, the staybolts; and possibly the problem of leaking tubes would be simplified by the adoption of a stable form of fire-box For large engines where clearance limitations prevent the use of much of a wagon-top, the Belpaire boiler offers the maximum steam space and free water surface possible. The writer believes that, whenever fair records of the comparative cost of maintenance have been kept, the rectangular form has justified its greater first cost. The occasionally-heard objection that the cross-stays impede circulation is untenable, for the increase in area of cross-section above the fire-box supplies more than the space necessary for the cross-ties. It is difficult to conceive of a device more poorly suited to its purpose than the radially-stayed boiler; and we may look for a revival of the Belpaire type as a characteristic feature of the next step in the development of the Americal locomotive.

G. F. STARBUCK.

Waltham, Mass.

JIG AND TOOL ROOM IMPROVEMENTS.

To the Editor:

During the past nine years I have been employed as a machinist and draftsman, by a number of railroads in different sections of the country. A year ago I decided to leave railroad work to enter the service of a private concern at nearly double the salary I was receiving as a draftsman with one of the foremost railroads of the country. After six months with my present employers I was promoted to take charge of the department of jig and small tool designing, with orders to go ahead and design a line of tools for interchangeable manufacturing. This was so successful that within the last three weeks another raise of salary has been given me. A careful study of this line of work, together with a number of articles which have appeared in your journal, advocating systematizing and improving tool room practice in railway repair shops, has led me to believe that there is an excellent field for this work among the railroads. My experience as a mechanic has shown me that a vast amount of time and labor in railroad shops can be saved by a man who can devise ways and means of standardizing methods of manufacturing and repairing locomotive parts, also standardizing the parts themselves. I would like your opinion on this subject and upon the advisability of my returning to railroad work. I feel drawn to this work because of its interest and would be glad to again enter the service of a railroad to apply the knowledge and experience gained in connection with the jigs and the systematic tool room work in a manufacturing establishment. Railroads ought to appreciate the importance of this work. Do you think it would pay me to go back to my first love?

D. G. R.

EDITOR'S NOTE:—The advice given this young man in reply to this letter was that he should by all means return to railroad service, where commercial experience in connection with jigs and tool room improvements is more greatly needed than in any other line of manufacturing. In enumerating the roads paying a sufficient amount of attention to this class of work to warrant his entering the service without a sacrifice, it was impossible to give a large list for application for a position. The difficulty is that, much as one may dislike to admit it, railroads as a rule have not given a sufficiently high place to the idea of manufacturing in improving their shop methods. In the matter of special devices and jigs there lies a very great opportunity for improvement of shop methods, because though a plant may be well equipped with machinery and improved tool steel the time which may be saved by devices for laying out, setting and holding the work constitutes a large possibility of saving. This is because, as a rule, the time during which the machine is actually cutting bears usually a small proportion to the total time of doing the work. In this particular direction lies the greatest opportunity for the introduction of manufacturing methods, and it may be said that the nearer railroad shop practice approaches to commercial and manufacturing methods, the greater will be the output and the less the cost. The name of the author of this letter will be given to any one who is interested to inquire.

THE FORCE OF A BOILER EXPLOSION.—The boiler which exploded March 20th in the factory of R. B. Grover & Co., Brockton, Mass., with such disastrous results, was of the horizontal tubular type, 72 ins. in diameter and 17 ft. long. It carried 90 lbs. pressure, contained 240 cu. ft. of water and 103 cu. ft. of steam, the total weight of the water in the boiler being about 14,000 lbs. The April number of *The Locomotive*, published by the Hartford Steam Boiler Inspection and Insurance Company, contains an interesting and complete account of the disaster, which was caused by a hidden crack in a double-riveted lap seam. The discussion referred to includes a statement that the "maximum mechanical energy that could be developed from the heat that this boiler contained would, if it were applied properly and efficiently, be sufficient to raise the boiler and its contents to a height of 18,954 ft., or over three miles and a half." It is not stated that this was the amount of energy that was developed in the explosion, but this calculation shows the possibilities in such a case without any gratuitous assumptions as to the use or presence of dynamite or other high explosives.

POWDERED FUEL.—"Firing With Coal Dust" was the subject of a paper by Mr. E. Carey before the Liverpool Section of the Society of Chemical Industry. In connection with the Schwartzkopff system, the cost of drying and grinding coal, including repairs, depreciation, capital cost and wages, amounted to 10.7c. per ton, and the capital charges and wages for firing the fuel amounted to 8.24c. per ton, including the cost of the power for driving the machinery. The cost of the power amounted to about 2.6c. per ton of fuel, and that for the mechanism for feeding the powdered fuel amounted to about .54c. per ton. The total cost of preparing and burning a ton of powdered fuel was 22.14c. per ton. In the experiments described a 500-h.p. Sterling boiler was used, consuming about 50 tons of powdered fuel per week. The Schwartzkopff system of burning powdered fuel was illustrated on page 378 of this journal in December, 1900.

A SUCCESSFUL WOMAN PRESIDENT.—Mrs. S. A. Kidder, who succeeded her husband, the late John F. Kidder, as president of the Nevada County Narrow Gauge Railroad, in 1901, has brought that road from a wornout and wretched financial condition to a basis of 10 per cent. dividends on its capital stock. The road is 23 miles in length, of 3-ft. gauge, having 5 locomotives and 79 cars. For 18 years it had paid no dividends and is now in excellent financial and physical condition; the credit being unquestionably due to the ability of Mrs. Kidder. The San Francisco *Bulletin* presents a very interesting account of this unique performance.

PITTSBURGH'S TONNAGE.—In the busy years of 1902 the freight tonnage of Pittsburgh was 88,000,000 tons, which is double that of London, four times greater than that of Paris, and more than that of Boston, New York, Philadelphia and Chicago combined. It is estimated that this great volume of business will be exceeded in 1905, and it is probable that the railroads will not be able to handle it for want of equipment.—*Railway Age.*

SINGLE FIRE DOORS.—Decided preferences for one instead of two fire doors of wide firebox engines was expressed in a recent discussion before the International Railway Master Boilermakers' Association at Buffalo, a specially favorable report for single doors being made by Mr. B. T. Sarver, of the Pennsylvania Lines.

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TOOL EQUIPMENT FOR LOCOMOTIVES.

A railroad officer engaged in connection with improvements on an important road finds no difficulty in securing appropriations for improvements, because he began by looking up usually forgotten items which involve great expense because of multiplication. In the matter of locomotive tool equipment, he says:

"I expect to effect a net saving of from $30,000 to $40,000 per year on engine tool equipment. Some of our engines now cost us $1 per day for tools illegitimately and others on a tool kit worth about $50 or about 700 per cent. depreciation."

THE VALUE OF CLEAR REPORTS.

In their reports to their superiors young subordinate officials have an opportunity, the importance of which they do not fully realize. A superintendent of motive power, who is noted for his development of young men, requires his subordinates to make reports of special investigations in such form that they may be handed on to higher officials with mere letters of transmittal, thus giving the credit to each young subordinate for his work. When a report is presented in an incomplete or unsatisfactory form, the superintendent of motive power finds it necessary to rearrange the report, transmitting it over his own signature, and thus depriving the young subordinate of this opportunity. In such cases as this the superintendent shows the young man the result of his deficiency, and usually the next report is creditable and is passed on as desired. This superintendent of motive power has for a number of years been constantly surrounded with a lot of able young men, and the young men have under his direction developed rapidly and broadly. In this practice there is a moral for young men and also for motive power officials. The young men do not appreciate the possible importance of a single good report which gives the desired information in the way it is wanted.

PROPOSED M. I. T.-HARVARD ALLIANCE.

To go into the subject of the controversy over the proposed alliance between the Massachusetts Institute of Technology and Harvard University at length would require more space than can be given this subject in these columns. To those opposing this scheme, however, one thing needs to be said, viz., that the future of technical education so admirably begun by Technology is the important object at the present juncture. Giving all due credit to the schools of the past, present conditions in technical education do not seem to be advancing to correspond with the needs of the times, and anything which will broaden and improve the possibilities for training engineers quickly, efficiently and thoroughly should be sought after and earnestly supported by those who are looking into the future. If the proposed alliance offers an opportunity for meeting the educational needs in a better way, and this it seems to do, it should not be opposed by any one, and least of all by those who are proud of what the Massachusetts Institute of Technology has been. That school has had a standing second to none in the world, but it is at least open to question whether it is now advancing at all. It surely has suffered by the inbreeding of alumni into its faculty, and a change of methods seems necessary or it will fail to fill the important position which it has filled in the past. The possibility of producing a better school with the alliance with Harvard seems to have been overlooked in the many discussions, and this is believed to be far more important than any of the objections which have been raised to the possible alliance. Past traditions may be left to take care of themselves in an effort to prepare for the future. [Since the above was written the alliance has been decided upon favorably.]

FOOL-PROOF MACHINE TOOLS.

One of the leading machine tool builders who has spent considerable time in studying railroad machine shop conditions is responsible for the statement that 70 per cent. of the breakages of machine tools in railroad shops is due to the lack of proper care or attention rather than to any weakness of the parts or poor design. An example was cited of an expensive boring mill which had been in a certain railroad shop less than one month when the feed works were badly injured, due to carelessness of the operator in letting the two heads jam together. A number of these machines had been in shops, other than railroad, for a long time, but no accidents of this kind had occurred.

The machine tool builders have done much during the past few years to design their machines to provide against such accidents, and have tried as nearly as possible to make them "fool proof." In addition we find careful provision made for adjusting those parts which are subject to wear and for lubricating such parts with a minimum amount of attention. The machine tool builders are to be commended for their efforts in this direction, but these things are useless if the user of the machine does not regularly supply oil for lubrication and carefully examine the machine and see that all wear is taken up. In an extensive visit to a number of railroad shops only two roads were found where any attempt was made to have the machine tools frequently and regularly inspected and repaired. What better investment could be made in a railroad shop, if the amount and accuracy of the work turned out and the increased life of the tools are considered, than to provide means for systematically and frequently inspecting all the machine tools. There are times when prompt attention requiring a few hours' work will add years to the life of a tool, to say nothing of the greater accuracy of the work it will turn out, and yet how often do we find tools in such shape that a passerby can tell by listening to the rattling of the loose parts that the machine requires attention? When a $10,000 machine tool is operated by a $2 per day man a better grade of attention than he can give is required in order to prevent a high rate of depreciation.

A TREE-CLIMBING CONTEST.

One of the important trunk lines is a conspicuous example of what a railroad ought to be—a happy family of officers and men. It would naturally be expected that such conditions would result in satisfactory and economical operation. In answer to the writer's question, one of the subordinate officials said that the success of Mr. ——, the head of the organization, was due to the manner of that official in dealing with his men. He said: "If Mr. —— should issue a bulletin, ordering every man on the system to climb a tree at 11:15 a. m. to-morrow, you would see the greatest tree-climbing contest since the time of Noah." That was his way of expressing the loyal desire of every man to do what is wanted of him. The official referred to never has had a strike in any department. Many of his young men "stay up nights" to get results for him. They do not count the cost of pleasing him. They do not often leave for bigger offers elsewhere. This results from the personality, the ability of this official, and his thoughtful consideration of his assistants. Think this over.

AMERICAN VIEW OF COMPOUND LOCOMOTIVES.

A true view of the standing of the compound locomotive in the United States was one thing difficult for the foreign delegates to the International Railway Congress to obtain, and after that meeting of distinguished railroad officials has passed into history one of the European delegates writes, asking: "What, after all, is the opinion in America, of the compound locomotive?" After thoughtful study of what was said in Washington this delegate was in doubt, and addressed the question to this journal. The reply was as follows:

Those who have used compound locomotives in this country may be classified roughly into four groups. (1) Those who appreciated compounding from the first, and have made a continual success in using the principle. (2) Those who expected too much of compounding and were not willing to aid in its development. These found improved fuel economy, but increased cost of repairs and increased number of road failures. They have nothing good to say of compounds. (3) Those who understood compounds, were willing to give them the care which all locomotives require, and who wanted the saving in fuel which the compounds rendered possible. (4) The fourth, and most important, class favor compounds because they provide increased capacity for work, and enable the fireman to shovel more horse-power into the firebox. This class is helping in the development of design, and compounds are wanted because they will do work that cannot be done by simple engines. These men realize that compounds are usually heavy, powerful engines, and that they require correspondingly increased care in maintenance because they are large, and not because they are compounds.

STAR PERFORMANCES IN SHOPS.

In a shop having about 1,200 men a number of production improvements have recently been made, one of which has attracted the attention of shop managers all over the country. The superintendent of this shop is pleased to have this record known and in connection with it has said a wise thing to his foremen and other assistants; he has said to them: "We have a fine record on that machine and it is well enough for people to know about it as well as about some other records we are making. You must not forget, however, that each of these particular jobs usually affects one man only in the shop. We must not forget that there are 1,199 other men employed in this plant, each one of which should make his record and that record making should extend even to the darkest corners of the plant. One individual record, or excellent work done by half a dozen men may give reputation to a shop, but what we are after is the record of the whole 1,200 men on the pay roll, which is reflected in the net earnings of the road. We are here for the reputation for net earnings rather than for a few star performances which will catch the eye of visitors but make relatively small impressions on output. Do not forget the 1,199 men."

VARIABLE SPEED FOR MACHINE TOOLS.

While it is undoubtedly advisable to provide such machine tools as lathes, boring mills and drilling machines with a large number of speeds, especially if they are to be used for general work, yet those familiar with railroad shop conditions must feel that the limit has been passed when from 40 to 80 speeds are advocated in connection with these machines. It is questionable if the average operator could work so closely to the limit of the tool steel as to require as many as forty different speeds on an engine lathe even if working under the direction of a speed foreman. The writer noticed in one large shop several engine lathes (16 to 20 ins.) which were seldom required to turn work larger than 3½ or 4 ins. indiameter and yet each one of them was provided with at least 40 different spindle speeds which would give less than 10 per cent. speed steps over the total range of work which it would be possible to handle on such lathes. It would seem that the same results could be obtained in a shop of this kind with a smaller expenditure by assigning certain classes of work to each machine and adapting the speeds to the particular work handled on each machine. This is especially true in the case of lathes and drilling machines.

THE BREAKAGE OF LOCOMOTIVE FRAMES.

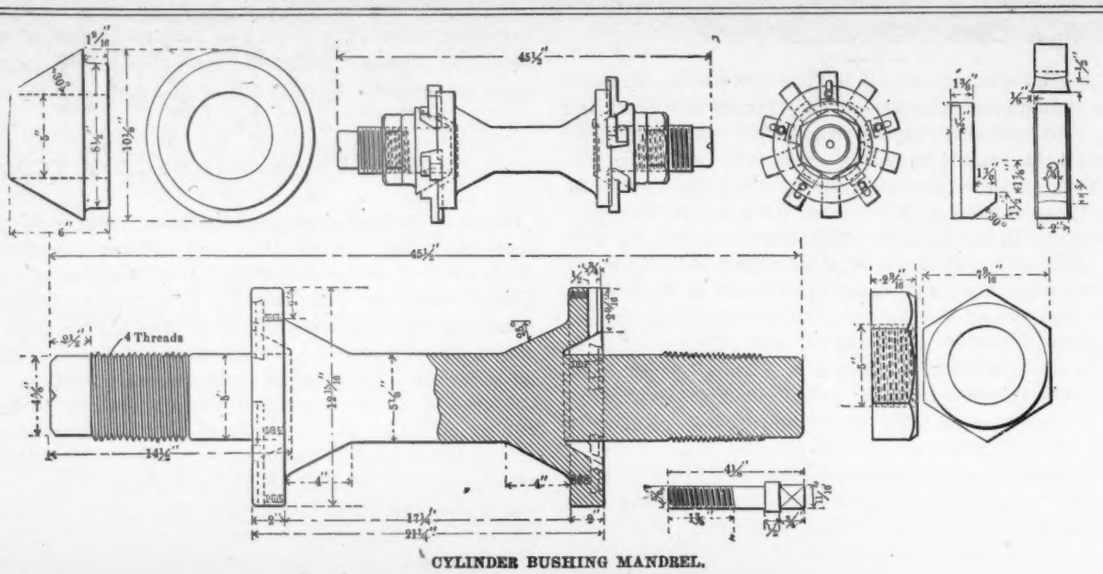
Locomotive frame breakage is becoming a serious matter which troubles everybody who has to do with large locomotives. It does not occur often with the lighter engines of 8 and 10 years ago, but is really mysterious in recent designs. Frames have been strengthened, stiffened and widened without overcoming the trouble or even discovering the reason for it. Some think it due to water in the cylinders and attribute it to the piston valve until they learn that slide valve engines are as bad. Some say it is due to the frequent reversal of the very heavy stresses from the cylinders, coming eccentrically upon the front sections of the frames, between the cylinders and leading drivers where most of the breaks occur.

On the Lake Shore it has been believed to be due to twisting of the frames and thus far engines fitted with deep cross braces, such as were illustrated in this journal in November, 1903, page 416, have not developed this weakness. The new Class K 2—6—2 type passenger locomotives of this road have 6-in. frames which are braced in this way, as illustrated elsewhere in this issue. These will be watched with great interest.

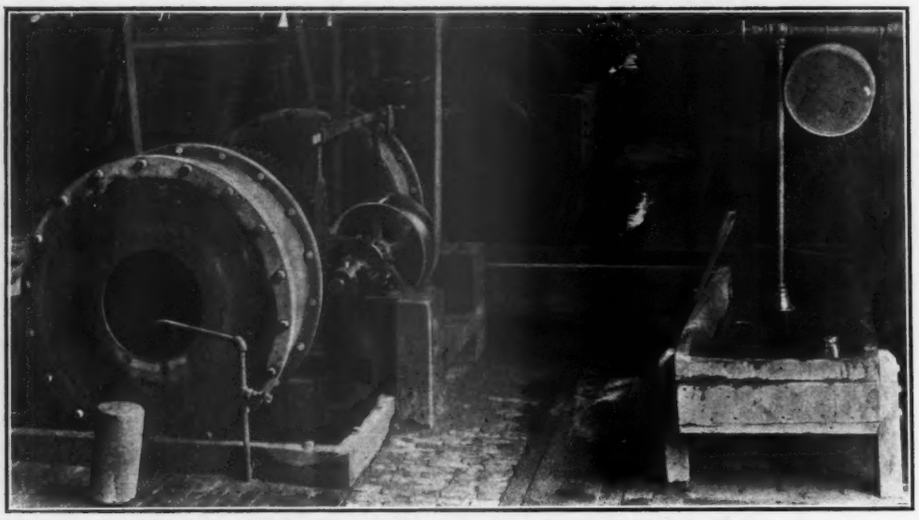
Pedestal binders are now almost always made of rectangular section with ample flat bearing surfaces in the form of notches against which the ends of their jaws bear, and these have prevented most of the breakage of frames over the driving boxes. When bolts are used, water in the cylinders tends to stretch them unless they are made very large, and when large enough they are too large for convenience in the roundhouse.

What seems to be needed is a combination of two remedies. First, to brace the frames laterally as is done by the Lake Shore and, second, to reduce the frame stresses as is done in the four-cylinder balanced compounds. This is one important argument in favor of these compounds where the frame stresses between the forward driving axle and the cylinders are almost entirely neutralized.

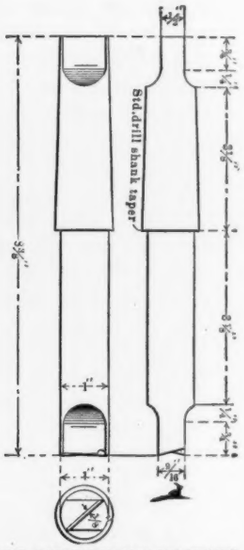
Another possible precaution is to substitute plate for bar frames, and this is an apparently important possibility. Frame breakage has become so serious as to justify a trial of plate frames in two-cylinder engines and it would be wise to investigate the possibilities of such construction in American practice under present conditions. But the plate frames will undoubtedly require the lateral bracing against twisting stresses, as this bracing has for years been practiced in foreign locomotive construction.



CYLINDER BUSHING MANDREL.

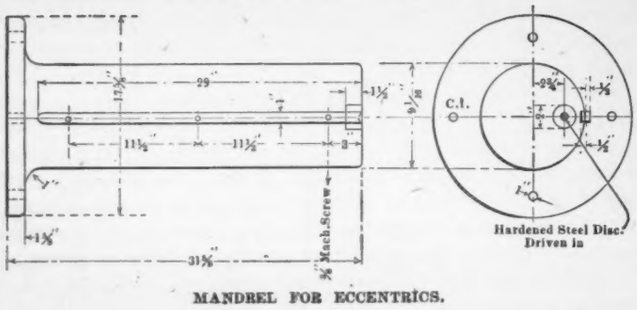


CINDER WASHING MACHINE.



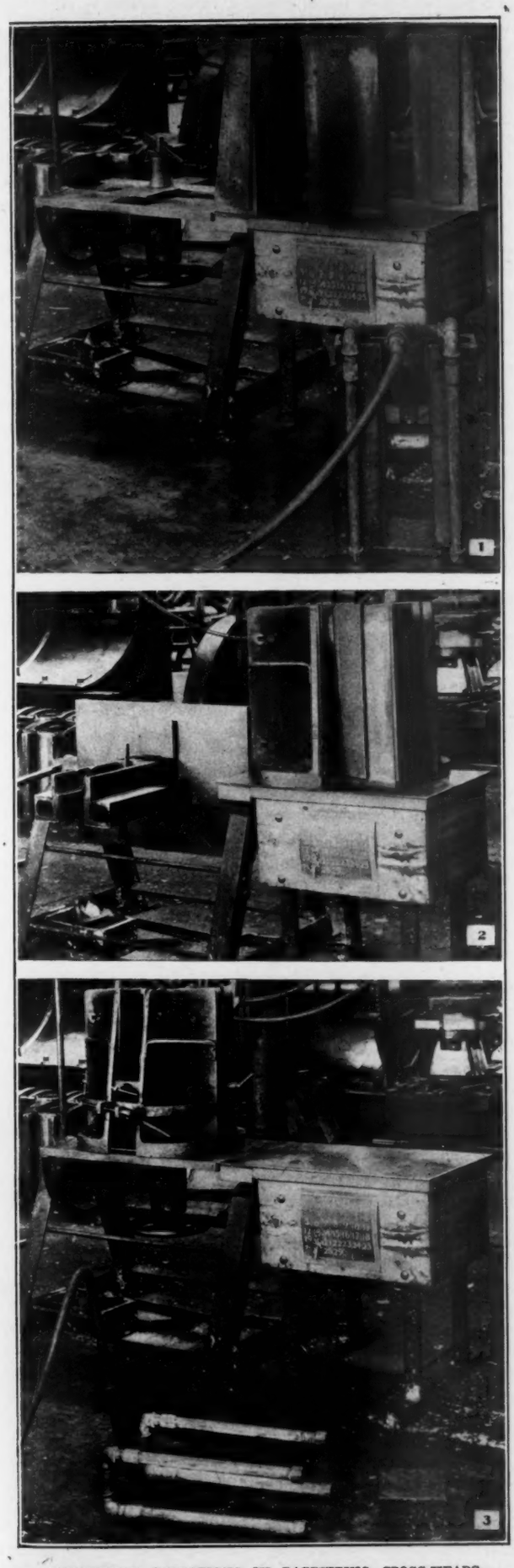
DRILL FOR KEYWAY MACHINE.

ECCENTRICS ON THE MANDREL.



MANDREL FOR ECCENTRICS.

DRIVING AXLE KEYWAY MACHINE.



SUCCESSIVE OPERATIONS IN BABBITTING CROSS-HEADS.

PRODUCTION IMPROVEMENTS.

CYLINDER BUSHING MANDREL—L. S. & M. S. RY.

Considerable time is saved by means of the cylinder bushing mandrel shown in detail in the drawing, because of its being self-centering and the bushing is so securely clamped that it is possible to take heavy cuts and run at a higher rate of cutting speed than would otherwise be possible. The jaws are forced outward by tightening the nuts. The bushings are turned at a cutting speed of 30 ft. per minute, with a roughing cut about ¼ in. deep and a 1-16-in. feed and a finishing cut 1-64 in. deep and a ⅜-in. feed. Three sets of jaws are provided to take care of the various sizes of bushings. When the proper jaws are in the mandrel a bushing can be placed on it in about 30 minutes. The time for turning a bushing 21 ins. inside diameter and 40 ins. long averages about 4 hours. The mandrel is heavy enough to carry a 17-in. cylinder with the saddle and has been used for facing off the ends and turning the flanges of cylinders.

KEY WAY MACHINE.

The key way machine shown in the photograph saves about 50 per cent. in time over doing the work with a ratchet drill and cutting out between the holes with a chisel, and about 25 per cent. when a motor is used instead of a ratchet. It also makes a much better job than when dressed by hand. The drill is driven by a No. 1 Little Giant air motor, which is supported by the two arms of the bracket. The vertical feed is obtained by means of the hand screw and the longitudinal feed by means of the ratchet and screw. The machine is held firm'y on the axle by means of clamps, as shown. The special form of drill shown in the drawing has been found to give the best results. The key way is laid out by a template and the drill is fed into the work ⅛ of an in. deep at each end and is then moved the length of the key way by the ratchet and screw. The drills are made of Blue Chip steel and 4 key ways can be cut complete in 5 hours; this includes the time for setting up and taking down the machine.

MANDREL FOR ECCENTRICS.

One end of the mandrel shown in the drawing is bolted to the face plate of the lathe. The photograph shows it on the lathe with five eccentrics just being finished. Where four eccentrics are turned at one time about five hours are required for the entire operation, including the mounting and dismounting of the eccentrics on the mandrel. We are indebted for this information to Mr. C. W. Cross, master mechanic at Elkhart, Ind., and Mr. R. B. Kendig, mechanical engineer.

BABBITTING CROSS-HEADS.—CHICAGO & NORTHWESTERN RY.

The method of babbitting cross-heads employed at the Chicago shops of this road avoids the necessity of planing the babbitted surfaces, the babbit being cast in one piece on the cross head in such a way as to leave a satisfactorily smooth finish without planing. The first of the three photographs shows a tilting table, with a small bench beside it. This table, which is of cast iron, has at its center a taper plug to enter the piston rod fit of the cross-head. The cross-head is held in place by a key. At the base of the plug is a cross of sheet metal upon which the cross-head rests. This cross is better shown in the second engraving, which shows the table tilted down. The first two engravings illustrate the angle casting which rests upon the table, and with the cross-head forms the spaces into which the babbitt is poured. The first engraving illustrates the gas heater as applied to the cross-head to warm it up to receive the babbitt. The third engraving shows the angles in place, and held by a hoop with a clamp in position for pouring. The plates held to the angles by bolts in slotted holes prevent the escape of the babbitt at the sides. The gas heater is also used to melt the old babbitt from the cross-heads. This is a very inexpensive plan for doing this work, and the results have been entirely satisfactory.

CINDER WASHING MACHINE.

While not in the line of a manufacturing machine, the cinder washer, which has been used at the brass foundry of these shops for a number of years, merits attention because of the saving which is effected. About six tons of skimmings and slag are washed in this machine every day, through which the daily saving in brass ranges from $20 to $25. Allowing for the amount of brass which may be picked out of the slag by hand, which need not go through this machine, at least $15 a day is saved by reclaiming metal which would otherwise be lost. The machine consists of a pair of cast iron drums mounted upon the same shaft and driven by a spur gear at the center. The drums are open at the ends. Each drum has a roller made from an old axle, about 9 ins. in diameter, and 1 or 2 ins. shorter than the length of the drum. The purpose of the roller is to crush the material.

A stream of water is turned into the opening into each drum, and the machine stands in a water-tight box. One of the rollers is shown in the engraving. While the machine is in operation a continuous stream of water passes into each drum and the overflow passes into the sewer. The flume shown at the right of the machine is used to wash the crushed material after it is taken from the drums. Strips crossing this flume produce riffles, so that in washing the lighter material, such as coal and coke, falls over and the heavy material is retained.

This machine crushes all the sweepings from the floor, all the skimmings, slag and ashes from the crucible fires—in fact, all the refuse from the brass foundry passes through this machine after being sifted through a coarse screen. The large pieces which will not pass through the screen are crushed with a sledge to about 1½ ins. in diameter, after which they are shoveled into the drums. The rollers crush all the softer material, much of which is washed out by the water. The remainder is shoveled on to the flume, after passing through another screen with ¼-in. meshes. After washing in the flume the remainder is practically clean metal.

We are indebted to Mr. H. T. Bentley, assistant superintendent of motive power, and Mr. Oscar Otto, general foreman of these shops, for the photograph and information.

TIRE TURNING RECORDS.—One of the manufacturers of tool steel in 1897 cited the following as excellent practice in tire turning: Speed of cut, 8 ft. per minute; for 54-in. tires, 2 minutes per revolution; roughing feed, ⅛ in.; finishing feed, ¼ in.; time cutting, 136 minutes; time flanging, 45 minutes; changing tools, 45 minutes; gauging, 10 minutes; finishing cut, 48 minutes; miscellaneous time, 30 minutes; time changing wheels, 45 minutes; total time per pair of wheels, 359 minutes. This is 6 hours per pair of 54-in. wheels. In 1905, eight years later, this has been reduced to 2 hours and 3 minutes for a pair of 84-in. wheels with Krupp tires. The cutting speed, feed and depth of cut have increased, but even in greater ratio have the methods of handling the wheels into and out of the machines improved, and also methods of holding the wheels in the lathe and driving them, so that heavy cuts may be taken without chattering. Improved tool steels have brought many improvements, besides larger and faster cuts. They have tuned up entire shops to a high pitch in handling work. As to tire turning, a pair of 84 in. wheels finished in an hour is the promise made for a new specially designed lathe, which is soon to be built. If this is accomplished, the work will be done in 30 minutes less time than that required in 1897 for changing tools added to that for changing wheels, not to mention the cutting and other items of time.

COST OF FLUE WORK.—In one of the newer railroad shops the editor of this journal was shown through the boiler shop and stopped at a well arranged flue-handling department. On inquiring the cost of the flue work the superintendent replied that he would give no figures of production as the work was then costing him four cents for putting a flue into condition to use again in a boiler. He expected to reduce this cost 100 per cent. and then would gladly give the figures of production. In view of the fact that in some shops this work is costing 25 cents per flue and in other shops 15 cents the modesty of this superintendent is to be admired. His intention to reduce the cost below that of the lowest record in the country is also to be admired, the lowest cost yet reached is believed to be 2½ cents.

CARE OF TWIST DRILLS.—Although the destruction of drills is always great, and may be legitimate even when on an extensive scale, nevertheless, proper methods may be devised whereby considerable saving can be effected without shortening the tool capacity. For instance, a twist drill will drill better, longer, more quickly, and more evenly if it is properly ground, and not ground once in every few days; but if work on it is crowding, every hour or so.—*Mr. R. Emerson, Engineering Magazine.*

RAILROAD SHOP SMALL TOOL EQUIPMENT.—Many shop managers will be alarmed at the prospect of employing not one, but half a dozen to a dozen extra men for supervising and maintaining a thoroughly effective tool system; but it must be remembered that the wages of a few cheap men (and old men are often very careful in such matters) are a small item compared to the time and money saved to the mechanics.—*Mr. R. Emerson, Engineering Magazine.*

PRODUCTION IMPROVEMENTS.—Broadly speaking, the economies that may be brought about in the very first year, by an intelligent analysis of tool conditions, and energetic introduction of method, will be surprising—will seem incredible to those who have not studied actual cases closely. Spending money on men and on the best tools, is one of the wisest forms of retrenchment.—*Mr. R. Emerson, Engineering Magazine.*

TIME ELEMENT IN MANUFACTURING.—The element of time was far less considered formerly than now, because it was of far less value. When wages were low and handwork in vogue, the ratio between the value of materials and of time was the reverse of what it is now, when in many manufactures the time cost exceeds all other costs.—*Mr. Alex. E. Outerbridge, Jr., Am. Academy of Political and Social Science.*

HEATING AND VENTILATION, MACHINE SHOP.

SOUTHERN RAILWAY, SPENCER, N. C.

The total cubical contents of this building aggregates about 4,500,000 cu. ft., and the apparatus for heating and ventilating it includes two special steel plate fans with 9½-ft. wheels 4½ ft. in width, these being placed upon elevated platforms. The lower portion of each fan extends below the platform and the air is discharged through outlets 60¾ x 54¾ ins. in section, inclined upwards at an angle of 45 deg. Each fan is driven by a 10 x 10-in. horizontal center crank engine, supported on a cast iron sub-base. Each heater is provided with 10,528 ft. of 1-inch pipe in the form of the Standard Sturtevant heater section. The apparatus is designed to operate under a steam pressure of 5 lbs. to maintain a temperature of 60 deg. as a minimum when the outside temperature is 10 deg. F. The elevation of the fans upon platforms permits of a gravity return of the water of condensation and also removes the fans from valuable floor space. The special interest of this application centers in the thorough manner of accomplishing the distribution of the air. All discharge pipes lead down to within 10 ft. of the floor, those on the outer walls being carried down in pairs, as it is impossible to secure at this point sufficient area for single pipes. These discharge pipes are recessed into the brick wall, avoiding all interference with the traveling crane. The overhead pipes are kept to the line of the lower chords of the roof trusses, and there is, therefore, no interference with the cranes from any part of the heating system.

PLANER SPEEDS.

In an effort to increase the output the speeds of the machine tools in several railroad shops have been considerably increased. A case recently came under our observation where the speeds for several planers were increased 50 per cent., or from 20 to 30 ft. per minute cutting speed and from 50 to 75 ft. per minute return speed. It was desired to make a still greater increase, for there was no question but what the machines would stand a considerably higher cutting speed than 30 ft. per minute, but this was not done, as it was thought unadvisable to use a higher return speed than 75 ft. per minute since the machines, although in good condition, were several years old.

ACTUAL NUMBER OF FEET CUT PER HOUR ON PLANERS WITH VARIOUS COMBINATIONS OF CUTTING AND RETURN SPEEDS.

Return Speed—Feet Per Minute.	Cutting Speed—Feet per Minute.									
	20	30	40	50	60	70	80	90	100	110
40	800	1028	1200	1333	1440	1527	1600	1661	1714	1760
50	857	1125	1333	1500	1636	1750	1846	1928	2000	2062
60	900	1200	1440	1636	1800	1940	2057	2160	2250	2329
70	933	1260	1527	1750	1938	2100	2240	2362	2470	2566
80	960	1309	1600	1846	2057	2240	2400	2541	2666	2779
90	981	1350	1661	1928	2160	2362	2541	2700	2842	2970
100	1000	1384	1714	2000	2250	2470	2666	2842	3000	3142
110	1015	1414	1760	2062	2329	2566	2779	2970	3142	3300
120	1028	1440	1800	2117	2400	2653	2880	3085	3272	3443
130	1040	1462	1835	2166	2463	2730	2971	3190	3391	3575
140	1050	1482	1866	2210	2520	2800	3054	3287	3500	3696
150	1058	1500	1894	2250	2571	2863	3130	3375	3600	3807
160	1066	1515	1920	2285	2618	2921	3200	3456	3692	3911
170	1073	1530	1942	2318	2660	2975	3264	3530	3766	4007
180	1080	1542	1963	2347	2700	3024	3323	3600	3857	4096
190	1085	1557	1982	2375	2736	3069	3376	3664	3931	4180
200	1090	1565	2000	2400	2769	3111	3428	3724	4000	4258

The accompanying table shows the actual number of feet cut per hour on planers with various combinations of cutting and return speeds. It will be seen that with a cutting speed of 20 ft. per minute and a return speed of 50 ft. per minute the actual number of feet cut per hour would be 857, and an increase of 50 per cent. would bring this to about 1,285 ft. per hour. The suggestion has been made that in the above case the ratio between the cutting and return speeds could have been changed at a small expense by changing the size of the pulleys, and that by leaving the return speed at 75 ft. per minute and increasing the cutting speed 33 per cent., or 10 ft. per minute, the actual number of feet cut per hour could be increased to about 1,565, and still be within the limits of the machine.

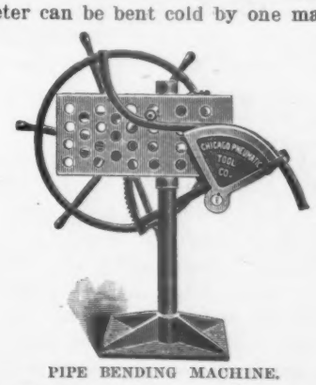
In this connection it might be well to note that in another railroad shop, where remarkable results have been gained towards increased output, some of the planers are operated at a cutting speed of over 50 ft. per minute. These planers are practically the same as those considered above, and as they are standing up well under this heavy duty it would seem that a cutting speed of 50 ft. per minute, for certain classes of work might be used in place of 40 ft., on some of the machines, thus increasing the actual feet cut per hour to 1,800, which is an increase of 15 per cent. over that with a 40-ft. cutting speed, and is twice as great as that originally provided for. Referring to the table, it will be seen that where the rate of cutting speed is less than that of the return speed much greater gains in output can be made by increasing the cutting speed a certain amount than by increasing the return speed the same amount; for instance, with a cutting speed of 30 ft. per minute and a return speed of 60 ft. per minute, increasing the return speed to 70 ft. per minute would increase the feet cut per hour only 60, while increasing the cutting speed to 40 ft. per minute, with a return speed of 60 ft., would increase the feet cut per hour from 1,200 to 1,440, or 240. While in most cases it is not possible to make any very great changes in the return speeds of old planers, as they are about as high as the design of the machines will permit, it is possible to considerably increase the cutting speeds, and a small increase in this direction will materially increase the output.

An inspection of the way the work is being handled on planers in some of the shops would indicate that there is considerable room for improvement in the method of clamping the work to the platen. Cutting mild steel guide bars at the rate of 25 ft. per minute, even with a very heavy cut, is entirely too low, and yet the means provided for clamping these guides in several cases were so poor that the operators were obliged to confess that they were limited as to the amount of feed which could be used when cutting as slow as 25 or 30 ft. per minute. This refers to the design of guides where they are thickest, through the middle and on one side taper towards the ends. The same thing, however, is true of several other kinds of work, and until these methods are improved it will be, of course, impossible to do much towards increasing the output.

Much was said a couple of years ago about the difficulty of driving planers at high speeds with individual motors, because of the high peak in the load at the reversal, but with a heavy pulley on the driving shaft, acting as a flywheel, and with the cutting speeds increased so as to more nearly approximate the return speeds, and with the heavy cuts allowed by the high-speed tool steels the power required at reversal is very little greater than used on the cut, and we find that the machine tool builders have no hesitation in recommending the use of motor drives in such cases.

PIPE BENDING MACHINE.

By means of this machine, illustrated in the engraving and which is very simple in construction, an ordinary helper can easily bend a piece of pipe to any desired curvature in a small proportion of the time required by a skilled mechanic using ordinary devices. Because of its light weight, it may readily be carried about the shop, and can easily be fastened to any column, stanchion or other available support in a few minutes, or it may be furnished with a suitable stand, as shown in the illustration. Iron, steel, brass or copper pipe up to 2 ins. in diameter can be bent cold by one man. Special dies



PIPE BENDING MACHINE.

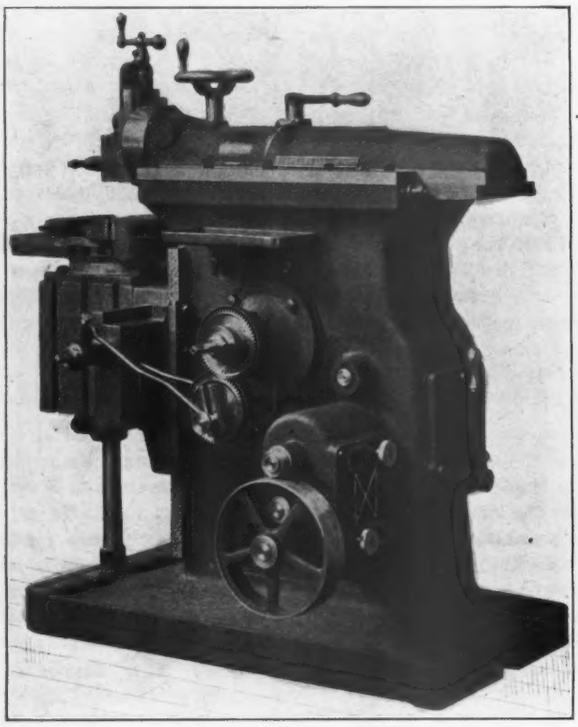
may readily be attached for bending light angles, flats or tee bars to any desired radius.

Galvanized or tinned pipe or pipe coated by the Sabin process may be bent with this device without breaking the coating. It is said that one man, without any assistance, can bend a 2-in. pipe to an S bend in three minutes. The cost of repairs where it has been used 10 hours a day in ship yards and railroad shops, has been very small. This machine has been thoroughly tested in the navy yards, and is manufactured by the Chicago Pneumatic Tool Company of Chicago.

CRANK SHAPER WITH GEAR BOX.

The Cincinnati 16-in. back geared crank shaper, shown in the photograph, is driven through a gear box which furnishes four changes of speed. This arrangement allows the use of a large area of belt contact at all speeds, and change from one speed to another can be made in much less time than where the cone pulley is used. The design of the gear box is simple and strong; it contains three shafts, two of which carry sliding gears which may easily and quickly be moved and locked by means of the two hand nuts shown at the rear of the box. This speed box may be attached to any Cincinnati back geared shaper at any time, though it is preferably done while the machines are in process of construction.

Other notable features of the 16-in. standard back geared crank shaper which is very powerful for its size are the careful and rigid design of the columns; the large bearing for the ram; the deep, heavy and strong design of the rail; the cross feed connecting rod, which is automatically adjustable to any height of the rail and is not dependent upon frictional contact; the outer support for the table, which is carefully designed for maximum efficiency; the elevating screw of telescopic form, which is provided with ball bearings, and is out of the way of falling chips; the vise, which permits straight or tapering pieces to be securely clamped with equal facility and rapidity, and has a graduated swiveling base; the means which are provided for compensating for wear and for the lubrication of the rocker arm; the provision made for the key-seating of shafting and similar work; the fact that the length of the stroke is changed from the working side of the machine, its position is changed by means of the hand wheel at the top of the machine, and either of these changes may be made while the machine is at rest or in motion.



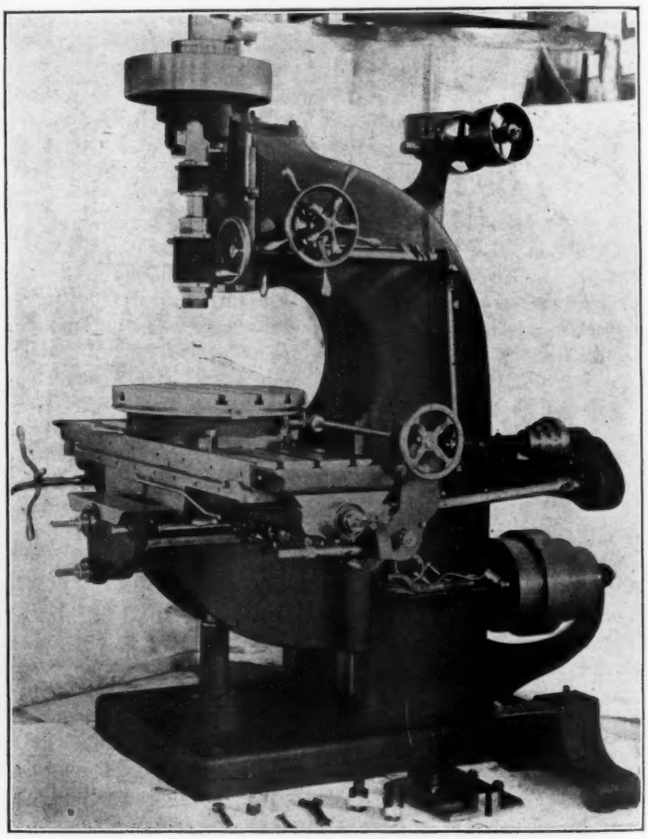
CRANK SHAPER WITH GEAR BOX.

The crank block is a steel forging, and is set well into the cup of the gear, permitting the rocker arm to travel close to the edge of the gear and thus avoiding the usual overhang. Full-length taper gibs, adjustable endwise by single screws, are used throughout. With the back gears in 24 revolutions of the cone shaft are made to one stroke of the ram. This machine is made by the Cincinnati Shaper Company, and its weight, including the countershaft, is about 2,600 pounds.

VERTICAL MILLING MACHINE.

That the railroads are beginning to realize the economies to be gained by the use of the vertical milling machine for certain classes of work and the wide range of work for which it is adapted is evidenced by the increasing number of these machines which are being introduced into the various shops. The accompanying illustration shows a No. 6 Becker-Brainard machine which is the same as the one in the Concord shops of the Boston & Maine Railroad, work on which was considered in connection with the article on "Vertical Milling Machines in Railroad Shops" on page 228 of our June journal. Although this machine was especially designed for a heavy class of work it will handle the lighter and small work to equal advantage.

The vertical movement of the head is actuated automatically by a powerful worm gear. For boring purposes it is provided with an automatic stop which will throw out the feed at any point. It has also a quick return motion. A micrometer stop gauge at the upper left hand side of the head accurately gauges the depth of the cut. The spindle end is threaded to receive large surface mills. Medium cutters are secured by a draw-bar passing through the hollow spindle. The table is ordinarily furnished with a longitudinal feed of 50 ins. The rotary attachment is fed automatically or by hand, with automatic stops for throwing out the feed at each end of the segment. Eight changes of feed are provided. Following are some of the principal dimensions:



BECKER-BRAINARD VERTICAL MILLING MACHINE.

Size of platen inside oil pocket	49 in. x 18 in.
Length of saddle	60 ins.
Longitudinal feed, automatic	50 ins.
Cross feed, with automatic stop	20 ins.
Vertical feed of spindle, automatic	13 ins.
Feed per revolution of cutter	.004 in. to .594 ins.
Range of spindle speeds	9 to 340
Greatest distance between spindle and platen	30 ins.
Greatest distance between spindle and rotary platen	24 ins.
Distance between center of spindle and neck	24 ins.
Vertical feed of knee, automatic	20 ins.
Diameter of spindle, main bearing	3¾ ins.
Diameter of spindle driver	20 ins.
Diameter of rotary table, inside oil pockets, 24 ins.; outside, 27¾	ins.
Size of hole in spindle	B. & S Taper No. 13

THREE-DRUM SANDER.

The Columbia three-drum, eight-roll sander, illustrated in the accompanying engravings, is economical in operation, and has several important features which enable it to produce a fine and accurate grade of work at a fast rate. The drums which carry the sandpaper are shown in cross-section in Fig. 3, and are equipped with an automatic paper tightener of simple construction, which keeps the paper at an even tension at all times. The machine is thus enabled to turn out a uniform and high grade of work, and the life of the paper is considerably increased. The mechanism is such that it is not necessary to take the cylinders out in order to re-cover them, and this operation is accomplished in one hour.

All parts which require any adjustment or attention are outside of the frame of the machine, and are easy of access, as may be seen by reference to the sectional view, Fig. 3. The oscillators which furnish the reciprocating movement to the drums have a non-cramping arrangement of levers which keeps their lateral movement in line with the axis of the shaft. The oscillators follow the raising and lowering of the cylinders for the changing of the cut with perfect freedom. The longitudinal, cross-sectional view of the oscillator, Fig. 4, shows the self-oiling boxes, the eccentric and strap, the three flexible joints which allow raising and lowering of the cylinders without disturbing the even motion, the collar on the shaft, as well as the outside collar, and the recess in the outside collar for taking up lost motion. The black lines between the collars and the box represent babbitt washers, which prevent wear on the boxes and which may easily be renewed.

FIG. 1—LEFT-HAND VIEW OF SANDER.

FIG. 2—RIGHT-HAND VIEW OF SANDER.

FIG. 4—SECTIONAL VIEW OF OSCILLATOR.

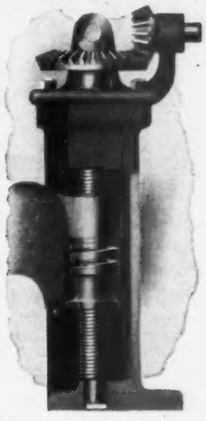


FIG. 7—DETAIL OF SUPPORT FOR UPPER FEED WORKS.

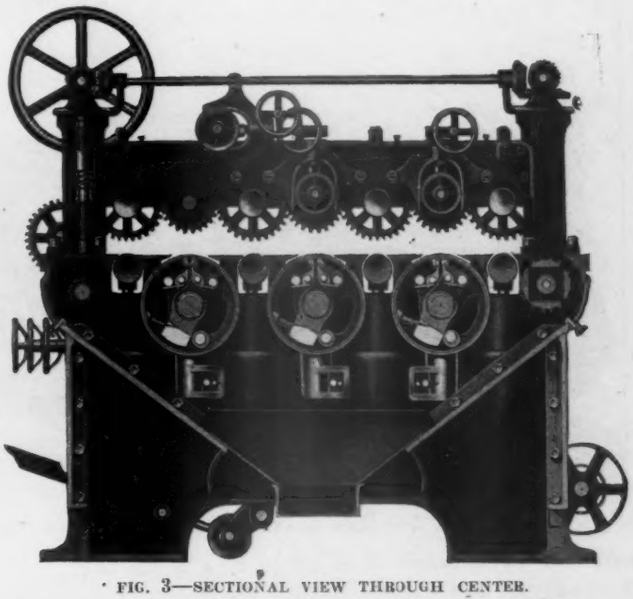
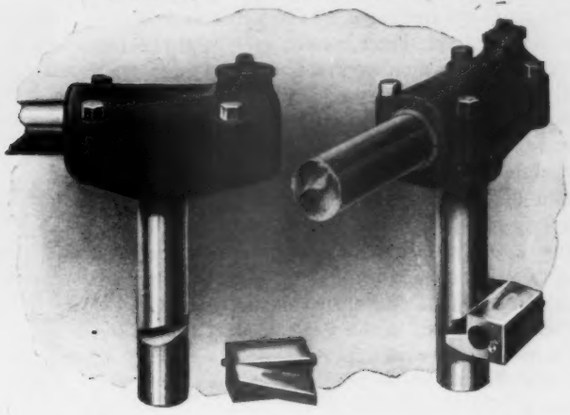


FIG. 3—SECTIONAL VIEW THROUGH CENTER.



FIGS. 5 AND 6—CYLINDER RAISING DEVICE.

The cylinder raising device is shown in Figs. 3, 5 and 6. This wedge arrangement allows no lost motion, and the cylinders are rigidly supported. The upper feed works is supported by four short screws, with bearings at both the top and the bottom, as shown in Fig. 7. A second nut and a coil spring are provided to take up back-lash in the screws, preventing swaying of the top frame when feeding thick stock.

This sander is the only one which provides for more than one rate of feed. This is done by changing the size of the feed gear just above the step or treadle, shown in the right-hand view. The four gears which are furnished give feeds of 12, 15, 18 and 21 ft. per minute, and it is thus possible to adapt the feed to the finish required. A power hoist for raising and lowering the top feed works is provided, and also an instantaneous feed stop for use in case of accident. The Columbia sander is made by the American Woodworking Machinery Company in sizes from 3 0to 84 ins. in width.

HEAVY DOUBLE AXLE LATHE.

The Niles No. 3 double axle lathe shown in Fig. 1 is remarkable for its simplicity and great power. Sixteen standard axles with 5½ x 10 ins. journals may be rough turned and finished from the forging sizes and the journals may be

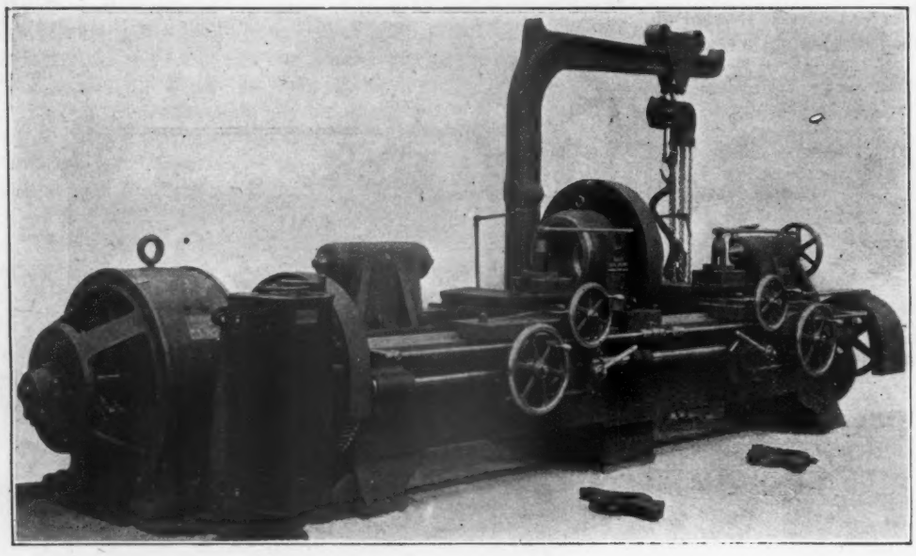


FIG. 1—NILES HEAVY DOUBLE AXLE LATHE—MOTOR DRIVEN.

burnished in 10 hours. It is driven by a 20-h.p. Westinghouse type S motor, which is geared direct to the machine and has a speed variation of 4 to 1. The standard belt drive, shown in Fig. 2, provides six speeds by means of the three step cone for a 6-in. belt and the change gears which furnish the higher speeds for finishing and which may easily and quickly be operated by means of the heavy jaw clutch. The driving cone shaft is well supported by an outer bearing attached to its base plate.

The lathe will take axles up to 8 ft. between centers and has an opening of 12½ ins. through the center head. The sleeve of the driving gear has ample bearing in the fixed head at the center. An improved type of driving dog is used, and to insure true work the face driver has a compensating device to equalize the drive and prevent the tendency to bend the axles. The center head has an adjustment in the bed so that for short work, such as locomotive axles, it may be moved toward the cone end. The tailstocks are massive in design in order to withstand the strain due to heavy cuts. They are adjusted by the handwheel at the right-hand end, and are rigidly clamped in position with 4 heavy bolts.

The carriages have very large bearings on the bed and may be easily and rapidly moved and adjusted. The tool post slide bearing on the carriage is very large to withstand the severe strains due to the burnishing tool action. Provision is made for drawing off and returning the lubricant to the reservoir from which it is pumped. Three positive feeds, 1-12, ⅛ and ¼ in. per revolution, are provided. which may quickly be changed by a pull pin at the right-hand end of the machine. The carriages have rapid hand traverse and an automatic release, which may be operated at any position along the work or to prevent striking the center head.

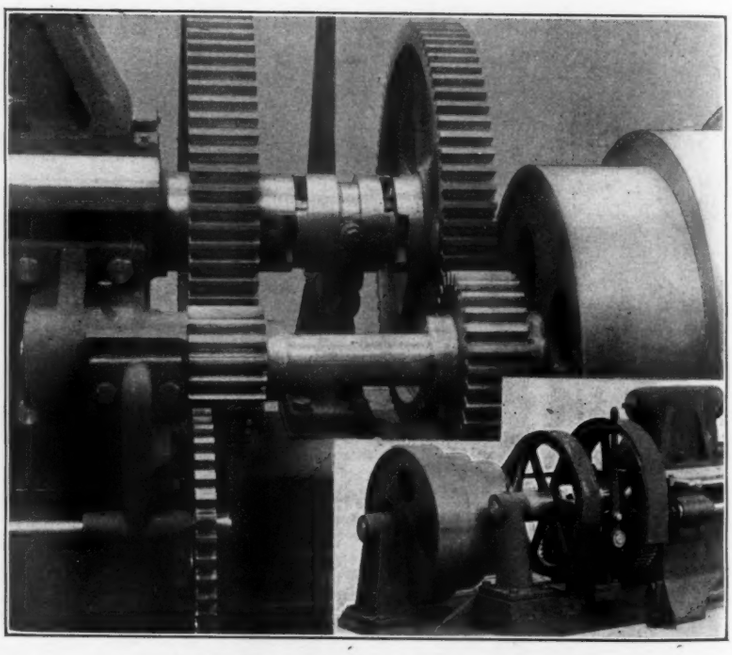


FIG. 2—DETAILS OF BELT DRIVE FOR AXLE LATHE.

WESTINGHOUSE FRICTION DRAFT GEAR.—The efficacy of friction draft gear has been shown in severe tests made with a 50-car train loaned to the Westinghouse Air Brake Company by the Pennsylvania Railroad, the tests having surprised a number of railroad officials, invited to witness them, in the extent of the unusual shocks absorbed and in the amount of freedom which friction draft gear gives the engineer in handling his train. Some of the tests which have been made are as follows:

With all slack bunched and the reverse lever in back motion the lever was suddenly thrown ahead and the throttle opened wide. Upon attaining a speed of 20 miles an hour a 10-lb. reduction was made and the brakes released as soon as the speed was reduced to 8 miles an hour, steam being applied to keep the train in motion. This is a severe test, but frequently occurs in practice. With all slack bunched and the brakes fully applied on the seven rear cars the engineer threw forward the reverse lever and gave full throttle. This test showed the power of the friction draft gear to absorb heavy shocks. Another test was to back the train at 8 miles an hour, reverse the engine and apply steam, this representing the extreme of carelessness on the part of the engineer. Another test was a rough start and applying the brakes at a speed of 20 miles an hour by means of the angle cock at the rear car while the engineer used a full head of steam. This produces an emergency brake application starting from the rear end. Another test consists in parting the train back of the fifteenth car, the forward section backing into the stationary part at speeds of 4, 6 and 8 miles per hour. This test was made to show the slight recoil and the amount of punishment the car will stand. Such tests as these have been made repeatedly in the presence of some of the best known railroad officials, demonstrating the capacity of the gear as far as anything but a service test can demonstrate it.

YOUNG MEN'S CHRISTIAN ASSOCIATION CONFERENCE.—Upon joint invitation of the city and railroad Young Men's Christian Associations of Detroit, the twelfth International Conference of the railroad department of the Young Men's Christian Association will be held in that city September 28th to October 1st. This promises to be the largest and most important gathering which this branch of the association has ever held.

VENTILATOR FOR PASSENGER CAR EQUIPMENT.

The demand for a positive ventilator for passenger car equipment has been such that the Safety Car Heating & Lighting Company have arranged for the manufacture of an improved form of the Andrew ventilator, which has heretofore been applied and is now in service on a considerable number of passenger coaches and is giving most satisfactory results. This ventilator, which is designed for application to a portion of the deck sash openings of a car, is of the exhaust type; operates on the ejector principle, and is automatically reversible, accommodating itself in operation to the direction of the train. Fig. 1 shows in elevation its application to the side deck of a car. It is shown in sectional elevation in Fig. 2 and in sectional plan in Fig. 3.

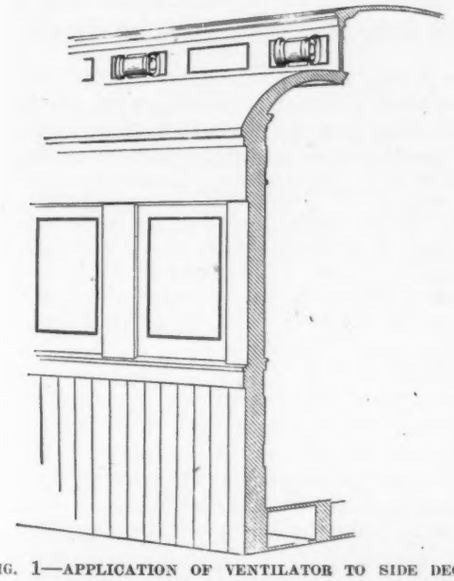
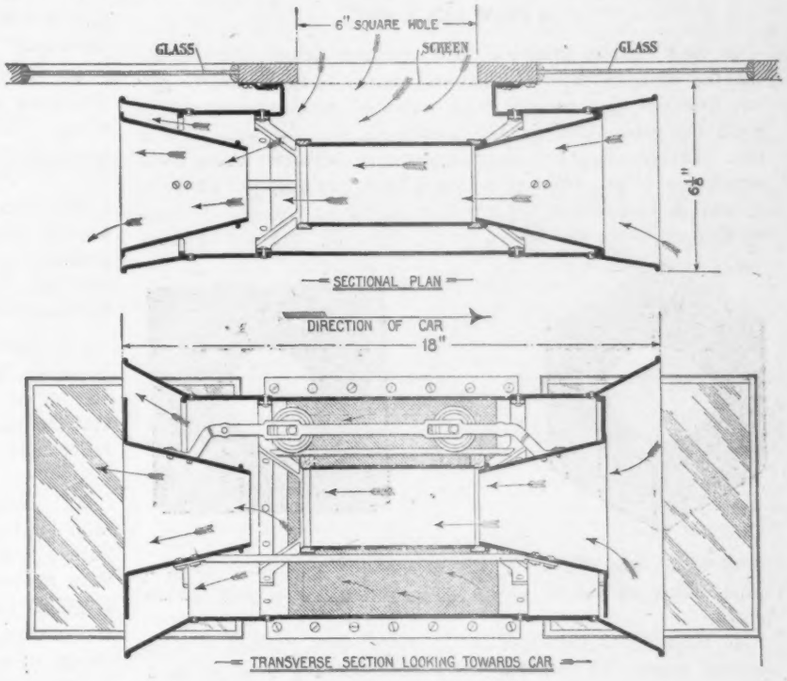


FIG. 1—APPLICATION OF VENTILATOR TO SIDE DECK.



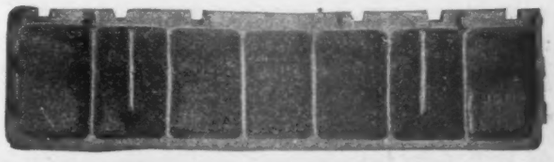
FIGS. 2 AND 3.

It is applied in connection with the deck sash openings, the screen being removed and a frame for the ventilator being substituted provided with glass, except for the 6-in. square screened opening for the ventilator connection. The ventilator thus communicates directly with the interior of the car when the deck sash is open. The deck sashes and their openings which are not fitted with ventilators need no alteration or attention; they may be opened for air supply or left closed. The ventilator is storm proof against transverse storms. The reversal of the ventilators for changes in the direction of the motion of the car is reduced to rolling friction; as a matter of fact, a speed of less than four miles per hour serves to reverse them, and their operation is noiseless. It is not necessary or desirable to apply ventilators to all deck sash openings, but for an ordinary passenger coach, one over each toilet room, and eight connected to the deck sash openings of the main body of the car, are sufficient, while for Pullman cars, one over each toilet room, two over small smoking rooms and four over large smoking rooms, two for each compartment and four for the main body of a twelve-section sleeper are sufficient. Tests show that the average amount of air exhausted by each ventilator at varying speeds is 24 cu. ft. a minute, or 1,440 cu. ft. an hour, and at that rate four of these ventilators applied to a large smoking room (say 6 ft. wide and 8 ft. long) will effect a complete renewal of the air in the room every five minutes.

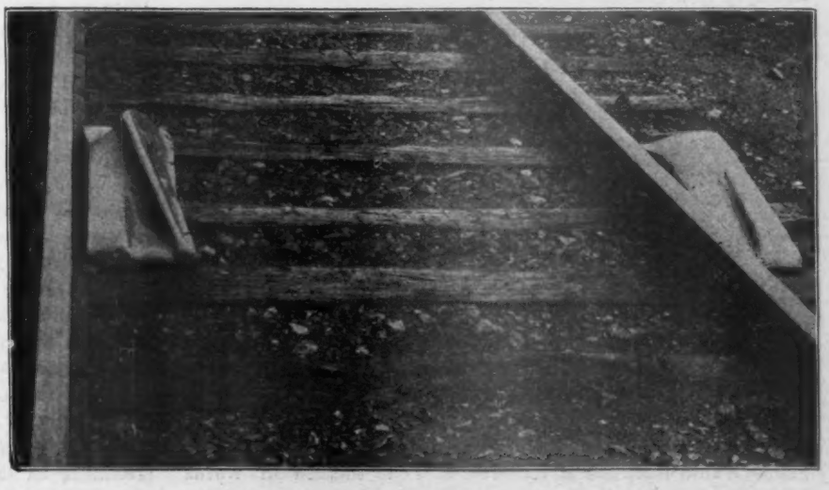
BUDA REPLACER.

The replacer which the Buda Foundry & Manufacturing Company has recently put on the market has several important features, the advantages of which have been demonstrated by numerous tests. One of these, which is clearly shown in the accompanying engraving, is the groove that protects the flange by allowing the tread of the wheel to first engage the replacer preparatory to mounting. The increase in the friction thus secured is very apparent. The tendency to shove the replacer out of position is also overcome, and there is no spinning of the wheels in the attempt to secure, on the flange alone, sufficient friction to start the ascent.

Another important feature is the reduction of the pronounced and abrupt arch at the ends. This has been accomplished without decreasing the strength required at these points, and the ascent is gradual and easy. The engraving shows how the inner replacer forces the wheel toward the rail. Repeated ex-



CONSTRUCTION OF UNDER SIDE OF REPLACER.

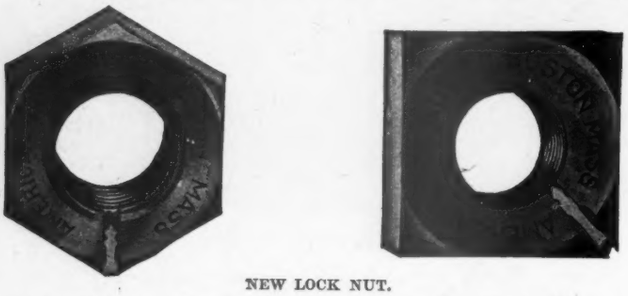


PAIR OF REPLACERS SHOWN IN POSITION.

periments have shown that it is not possible for the wheel to travel over the top of the replacer and drop on the opposite side. Tests made by the Hunt Bureau of Tests show that this replacer will sustain a load more than 2½ times as heavy as any locomotive now in use. The metal is so well distributed, however, that the weight of the replacer is not excessive. The small engraving shows the construction of the under-side of the replacer. Convenient carrying handles are provided. The replacers for 60-lb. rails weigh 150 lbs. per pair, while those for 100-lb. rails weigh 200 lbs. a pair.

A NEW LOCK NUT.

A very simple, practical and positive device, for rigidly locking nuts under all conditions, known as the Burrows patent lock nut, has recently been patented, and is being placed upon the market by the American Lock Nut Company of Boston. This nut lock has been subjected to the most severe tests, which prove that when once locked vibration does not affect it. It may be locked and unlocked an indefinite number of times without injuring the device or the bolt. By the use of these



NEW LOCK NUT.

nuts, which are shown on the accompanying illustrations, a considerable saving of time, labor and material may be effected.

Its mechanical principle is the right-angle contact of two cutting edges. In construction it is a rocking key, set in a slot in the upper surface of the nut, and which intersects the bore of the nut at right angles. In operation, the cutting edge of this hardened key engages the softer threads of the bolt, and the result is to hold the nut rigidly in place.

To operate, see that the nut is unlocked by driving down the outer end of the key until the other end clears the thread, allowing the nut to pass freely on the bolt. When the nut is thoroughly seated, lock by driving down the end of the key next to the bolt.

PERSONALS.

Mr. D. M. Knox has been appointed mechanical engineer of the Denver & Rio Grande with headquarters at Denver, Col.

Mr. H. P. Latta has been appointed superintendent of motive power of the Mobile, Jackson & Kansas City Railway, with headquarters at Mobile, Ala.

Mr. George Dickson has been appointed acting master mechanic of the Chicago, Cincinnati & Louisville at Peru, Ind., to succeed Mr. A. L. Moler, resigned.

Mr. J. M. Wisler has been appointed master mechanic of the Toledo Railway & Terminal Company, with headquarters at Toledo, O., succeeding Mr. H. P. Latta.

Mr. R. W. Burnett has been appointed master car builder of the Erie Railroad, with headquarters at Meadville, Pa., to succeed Mr. Robert Gunn, who is assigned to other duties.

Mr. A. C. Hinckley has been appointed master mechanic of the entire Cincinnati, Hamilton & Dayton, to succeed Mr. Mertsheimer.

Mr. W. B. Page has been appointed master mechanic of the Pennsylvania Railroad at Camden, N. J., to succeed Mr. Rufus Hill, resigned.

Mr. D. D. Robertson has been appointed general master mechanic of the Fort Worth & Denver City Railroad, with office at Childress, Tex., to succeed Mr. H. C. Van Buskirk.

Mr. F. Mertsheimer has resigned as superintendent of motive power of the Cincinnati, Hamilton & Dayton to become superintendent of motive power of the Kansas City Southern, succeeding Mr. W. E. Symons.

Mr. F. K. Erwin has been appointed construction engineer of the New York, New Haven & Hartford Railroad, with headquarters in Boston. He is in charge of shop construction and equipment.

Mr. B. A. Worthington has been elected vice-president of the Wheeling & Lake Erie and of the Wabash-Pittsburgh Terminal. He recently resigned as vice-president and general manager of the Oregon Railroad & Navigation Company.

Mr. Thomas Paxton, heretofore master mechanic of the El Paso & Southwestern Railroad at Douglas, Ariz., has had his jurisdiction extended over the El Paso & Northeastern System, and has been appointed superintendent of motive power of these lines.

J. O. Pattee, formerly superintendent of motive power of the Missouri Pacific and previously of the Great Northern, died May 25 as a result of a fall at his home in St. Paul. Since 1857 he has been continuously in railroad service until his retirement from the Missouri Pacific, three years ago.

Mr. George Gibbs, of New York City, has been appointed chief engineer of electric traction for the Pennsylvania, New York & Long Island and the Pennsylvania, New Jersey & New York Railroads. He has resigned as vice president of Westinghouse, Church, Kerr & Company and as consulting engineer of the Interborough Rapid Transit Company and will have charge of all of the electrical and mechanical engineering of the New York terminal work of the Pennsylvania and Long Island Railroads. He will also be consulting engineer of the Metropolitan interests. He will be responsible for the most important and greatest electric traction development of the time.

Mr. J. R. Onderdonk, engineer of tests of the Baltimore & Ohio Railroad, has been placed in charge of the test bureau of that road, which considerably enlarges the scope of his responsibilities, this bureau being responsible for the analysis, inspection and testing, in connection with all equipment materials and appliances bought under specification and all experiments connected with equipment and material are to be made under the direction of Mr. Onderdonk. This includes rolling stock, bridges, cement and other road department material. Mr. Onderdonk is 36 years of age, was "graduated in mechanical engineering at Stevens Institute of Technology in 1889; in 1890 he entered the service of the Baltimore & Ohio as a draftsman, and since January, 1891, he has been connected with the test department, and has for the last ten years served as engineer of tests for the motive power department." He is specially well qualified for the increased responsibilities of the new bureau.

Mr. Edward M. Herr has been elected first vice-president and chief executive, under the president, of the Westinghouse Electric & Manufacturing Company. It is not understood that Mr. Herr will sever his connection with the Westinghouse Air Brake Company, but that he will continue to direct its plans. It is a pleasure to record this further recognition of Mr. Herr's ability, and it is an interesting fact that his experience, which has been found so valuable, was obtained in railroad service. Beginning as a telegraph messenger boy, he has passed successively through the positions of station agent of what is now a part of the Union Pacific, mechanical draftsman, engineer of tests, superintendent of telegraph, division superintendent on the Burlington, master mechanic on the C., M. & St. P. Ry., superintendent of the Grant Locomotive Works,

was sent abroad to establish a locomotive building plant in Russia, returned to this country as manager of the Gibbs Electric Company in Milwaukee, after that he was appointed assistant superintendent of motive power of the C. & N. W. Railway, to be followed by his appointment as superintendent of motive power of the Northern Pacific. He has been with the Westinghouse Air Brake Company as general manager for about seven years, and under his direction exceedingly important improvements in the air brake have been developed. In view of the importance of the thorough knowledge of steam railroad conditions at the present stage of electrical development this appointment seems both fitting and necessary.

MASTER MECHANICS' ASSOCIATION.

ABSTRACTS OF PAPERS AND REPORTS.

THE USE OF SUPERHEATED STEAM ON LOCOMOTIVES.

By H. H. VAUGHAN.

EDITOR'S NOTE.—It is impossible to properly represent this paper without printing it in full, which lack of space prevents. All who are interested in locomotive practice should procure the paper itself, and study it carefully. It is the best treatment of superheating we have seen, and is the first thorough discussion of the subject as applied to locomotives. There seems to be nothing more important in the immediate future of locomotive progress. The Master Mechanics' Association is to be congratulated on the presentation of this timely and admirable paper.

HISTORY.

The use of superheated steam has rather a peculiar history; unlike the turbine, which lay neglected, with its possibilities unknown, through the years in which the reciprocating engine gradually attained its present state of perfection, superheating was employed and proved its value when the steam engine had already left the experimental stage, when reliable operation had become established, and economy was regarded as a matter of importance. After demonstrating the advantages that could be gained by its use, it was gradually abandoned by the large majority of engineers, and not again resorted to until successive stages of increasing pressure, ordinary multiple compounding, jacketing and refined designing, had been brought to their greatest perfection. When its reintroduction took place, its progress was slow, and years were required to obtain its recognition as a necessity in every plant where power is to be obtained with the greatest economy.

Superheated steam is supposed to have been first applied to locomotives on the Chicago, Burlington & Quincy Railway in 1870, the front tube sheet being set back some distance into the boiler, and the superheater, consisting of a separate cylinder in which the tubes formed practically a continuation of the boiler tubes and into which the steam entered by the dry pipe, and from it passed to the cylinders by pipes connected to the bottom. Such an apparatus could not have actually superheated the steam to any great extent, but it showed some economy which was not, however, considered sufficient to pay for its increase in cost and the trouble of maintaining it, and it was subsequently abandoned. The present development in the application of superheated steam to locomotives is due to Messrs. Garbe and Muller, of the Prussian State Railways, who in 1898 arranged to equip two engines, Hanover No. 74, built by the Vulcan Company, of Stettin, and Cassel No. 131, built by Henshel & Co., the design being prepared by Mr. Schmidt. In a paper read by Mr. Garbe in 1902, before the Berlin branch of the Institution of German Engineers, he related the various reasons that led him to a consideration of the advantages of superheated steam, and discussed in a comprehensive way the benefits derived from its use and the results at that time obtained.

During the present year, 1905, the Canadian Pacific Railway is building fifty-five simple ten-wheel freight engines and six Pacific type passenger engines, which will be equipped partly with the Schmidt and partly with modified Schenectady and other types of smoke-tube superheaters, and a number of other roads are also experimenting with this system, which is therefore fairly well started, experimentally, and is now in sufficiently extensive use to develop its troubles in regular service, and emerge from the nursing stage, which always engenders the suspicion that particular attention to one engine's performance may obtain results that would not be realized from a number.

The theoretical considerations involved in the use of superheated steam have been discussed so thoroughly in various papers and text-books on the subject that any extended treatment of them in this article is superfluous. It is necessary, however, to note certain facts in connection with this question on account of their bearing on the results that have been obtained and the designs of superheaters that are at present in use, and there are, besides, certain conditions in locomotive work which render some results important that do not generally apply in stationary practice.

When water is converted into steam, its temperature depends upon the pressure at which it is evaporated, and in steam, as it is commonly used in the saturated state, these quantities are absolutely dependent, to the extent that any further addition of heat to the boiler does not result in an increase in the temperature of the steam, but simply increases the amount of water evaporated, and, conversely, any abstraction of heat from the steam will immediately condense a portion of it. If, however, the steam, after being evaporated, is still further heated, it becomes superheated, and its volume increases in proportion to its rise in temperature. It is possible to heat steam in such a way that the volume remains constant and the pressure increases with the temperature, but this method cannot be carried out in a superheater, as the pressure is governed by the boiler with which the superheater is necessarily in communication, and consequently remains constant. The amount of heat required to raise the temperature of 1 lb. of steam 1 deg. under this condition is the specific heat of steam at constant pressure, and is not accurately known, although commonly stated to be 0.48, as determined by Regnault. More recent experimenters have, however, assigned to it a higher value, and in an article in *Power* for August, 1904, G. A. Orrok analyzed the experiments of Gruilly, Greissman and others, and showed that it probably varies with the pressure, and that its instantaneous value equals 0.00222t deg.—0.116, where t deg. is the temperature Fahrenheit. This corresponds to a value of 0.65 at 350 deg. and 1.0 at 500 deg., and is slightly higher than the latest determination by Mr. Jakeman, of the British National Physical Laboratory, who found it to be 0.59 between 290 deg. and 420 deg. at 60 lbs. pressure, so that, allowing for a possible increase in the last figure with the temperature, a value of 0.7 may be assumed in connection with locomotive problems, and this figure will be used in this paper where not otherwise noted.

In the case of an engine using saturated steam no heat can be abstracted from the steam to warm up the cylinder walls or steam passages without a sufficient amount of steam being condensed to furnish, by its latent heat of condensation, the heat required. This condensed steam is deposited over the entire surface in a finely divided state, and the larger portion of it remains as water until exhaust takes place, when, owing to the comparatively low temperature at which water is converted into steam at exhaust pressure, it is re-evaporated by absorbing heat from the cylinder walls, which by that time have attained a higher temperature than the exhaust steam. In the process of evaporation the water abstracts heat very readily on account of its close contact with the metal, and while being evaporated it can absorb a large amount of heat without its temperature being raised, about 950 B. T. U. for each pound converted into steam. In the case of an engine using a gas, where no condensation takes place, this interchange of heat is limited to a reduction of temperature during admission, and an increase of temperature during exhaust, of the gases in immediate contact with the walls, and since the heat required to raise or lower the temperature of a gas considerably is very small, the heat abstracted from the cylinder walls during exhaust is correspondingly less. Were 1 lb. of gas the amount affected by this action, it would only require 50 B. T. U. to raise its temperature 100 deg., showing the vastly greater capacity of a film or scattered drops of water to change the temperature of the metal with which it is in contact. The evaporation during exhaust of the water condensed on the walls during admission is the means by which their temperature is lowered, and by avoiding its condensation, their variation in temperature is greatly decreased. Superheated steam, having a temperature higher than that corresponding to its point of condensation under any given pressure, can part with a portion of its heat to the cylinder walls without being condensed, and will, if the superheat be sufficient, avoid it entirely, thus approximating the condition of an engine working with a non-condensable gas.

In an engine operating with saturated steam, there is, in addition to that shown on the indicator diagram as present in the cylinder, a quantity of steam passing into the cylinder at each stroke, which condenses into water during admission, and is re-evaporated during exhaust without performing any useful work; while, if sufficient superheat is employed to render the steam dry at cut-off, all the steam that has passed into the cylinder is that shown on the diagram, the heat absorbed by the cylinder walls being furnished by its drop in temperature in place of by condensation.

When steam is superheated beyond the point at which dry steam is present at cut-off, a still further gain occurs on account of decreased heat interchange up to the point where it is dry at release, which requires an increase in the superheat of from 50 deg. to 100 deg., according to the rate of expansion and other conditions, and in stationary practice, where an economical rate of expansion is invariably employed, superheating is rarely carried to this point. In locomotive work, however, engines are commonly worked at long cut-offs for considerable distances, and in such cases it is exceedingly likely, when the steam is considerably superheated, that superheat may occur at release. This is not a loss, as commonly stated, but is a gain due to the second advantage mentioned, that of a working fluid which may be used at high temperatures without excessive pressures.

By superheating, the temperature, and consequently the volume, can be increased considerably without increasing the pressure; thus, for steam at 200 lbs. (abs) superheated 200 deg., the P V divided by heat of production is 0.425, a gain of nearly 11 per cent. by superheating. This gain, which may be termed the economy due to volume, as contrasted with the economy due to temperature, which acts through the reduction of cylinder condensation, is evidently most effective when steam is used non-expansively or at long cut-off, whereas, the avoidance of waste in the cylinders is not important under those conditions, but operates when the rate of expansion is greater, and considerable loss would occur in an engine using saturated steam. The economy due to volume is obtained through the increase in the volume of steam when superheated, which enables a given weight of steam to provide the volume required for a greater number of strokes of the engine, and it is evident that the economy from this cause commences when the steam is dry at cut-off, and continues when superheat is present at release.

The conclusions to be drawn from these results are that, in locomotive work, should conditions be such that superheat occur

at the exhaust, no loss, but, on the contrary, a gain, is obtained; that this gain, while very valuable at long cut-offs, becomes of less importance as the cut-off is shortened, and a more important economy is then obtained through the avoidance of similar condensation. Since the economy obtained from volume is only 10 per cent., with a superheat of 200 deg., under favorable conditions, while that obtained from temperature may amount to 25 to 30 per cent., the latter is by far the most important, and while economies may be obtained at long cut-offs, the greatest will occur with expansive working.

EDITOR'S NOTE.—The paper at this point presents illustrated descriptions and discussion of all of the well-known arrangements of superheaters as applied to locomotives. This feature of the work must be omitted for lack of space.

RESULTS.

The results obtained from superheating appear invariably to have shown a decided economy. Starting with the instance previously referred to as reported by Trevethick, in which an economy of 30 per cent. was obtained with an unknown degree of superheat, but in which 7 per cent. of the total coal burned was used in the superheater, all of the various tests show a remarkable agreement in results. A short statement of a number of experiments, which follows, is interesting as showing a general agreement among a number of investigators.

EDITOR'S NOTE.—The results accorded include foreign as well as American figures. This abstract includes only the results obtained upon the Canadian Pacific Railway.

Turning from the results obtained abroad to those in America, the only figures so far available are those on the Canadian Pacific Railway, and on this road the records available are those obtained in service over a considerable period. These results, after all, must be the deciding ones, as in view of the influence of the boiler efficiency on the net economy, isolated tests will always be more or less unsatisfactory. It is possible to determine the water consumed per unit of power developed with considerable accuracy, but in determining the water evaporated per pound of coal, a factor must be taken into account that is independent of the boiler, and pretty near everything else on the road, in the efficiency of the fireman. It is quite possible, on a test, to obtain an evaporation that is decidedly better than that realized day after day in service, and while no doubt careful tests are desirable, and it is the intention to carry them out as soon as a dynamometer car is available for the purpose, yet the service results are so far satisfactory and are interesting as showing the economy actually obtained.

The records from engine No. 548 extend over a period of seventeen months, during which time this engine was compared with similar simple and Vauclain compounds in freight service and with simple and two-cylinder Pittsburgh compounds in passenger service. The dimensions of the various engines are as follows:

These engines were compared for periods in which they were running in corresponding service to No. 548 between Montreal

	Engine	No. of Class Running	Ton-Miles, Thousands	Total Coal, Tons	Coal per 1,000 E. G. Ton-Miles	Relative Economy	1600 to 1621
Chalk River to North Bay.							
January	1200	12	7,077	717½	202	100	
	1300	1	805	80¼	199	98	
	1600	5	5,111	410½	160	79	31
	1621	9	10,669	1,075	201	100	
February	1200	1	202	17½	173	100	
	1300	1	1,354	117¾	173	100	
	1600	6	7,542	612¾	162	93	14
	1621	8	8,728	824¼	188	108	
March	1200	1	316	24½	155	100	
	1300	1	770	56	145	93	
	1600	6	6,175	423¼	137	88	13
	1621	6	7,095	560¼	157	101	
April	1600	5	6,179	374¾	121	93	7
	1621	6	9,886	645¼	130	100	
North Bay to Cartier.							
January	1200	10	6,393	499	156	100	
	1300	1	713	48½	136	87	
	1600	4	2,008	146	145	93	4
	1621	6	9,307	708¼	152	97	
February	1200	2	1,590	137½	172	100	
	1300	1	565	44¼	156	91	
	1600	6	6,043	423¾	140	82	16
	1621	8	5,052	429	167	97	
March	1200	3	1,377	100¼	145	100	
	1300	1	728	50	137	95	
	1600	5	4,825	294	121	83	14
	1621	6	5,360	378¼	141	97	
April	1200	1	365	26	143	100	
	1300	1	191	9¾	102	71	
	1600	5	6,322	367½	116	81	8
	1621	6	5,599	352¾	126	88	
Chapleau to White River.							
January	1300	3	3,755	340½	181	100	
	1600	13	13,956	1,267¾	181	100	25
	1621	5	612	74½	243	132	
February	1300	4	2,696	239	177	100	
	1600	9	13,226	1,050¼	158	89	
March	1300	3	4,821	400¼	164	100	
	1600	10	19,106	1,348	141	86	
April	1300	4	2,518	193	153	100	
	1600	9	11,894	738¾	124	81	
Cartier to Chapleau.							
January	1300	3	3,373	322¾	191	100	
	1600	11	14,547	1,209¼	166	87	
	1621	7	1,170	110½	188	98	12
February	1300	3	3,979	332¾	167	100	
	1600	9	13,176	996¾	151	90	
March	1300	3	3,305	246¼	149	100	
	1600	11	21,942	1,450	136	91	6
	1621	1	265	17	128	86	
April	1300	3	2,726	204¾	150	100	
	1600	9	12,814	766¾	119	79	

Engine No.	548	616	595	634	482
Type	4—6—0	4—6—0	4—6—0	4—6—0	4—6—0
Kind	Simple S. H. Schmidt S'box.	Simple.	Compound 2-cylinder Pittsburg	Simple.	Compound. 4-cylinder Vauclain.
System					
Cylinders	18 x 24	18 x 24	20 & 30 x 24	18 x 24	13½ & 23 x 24
Drivers	62 ins.	62 ins.	62 ins.	62 ins.	62 ins.
Heating surface, fire tubes and firebox sq. ft.	1,116	1,291	1,291	1,428	1,614
Grate area	23.44	23.44	23.54	28.54	28.54
Boiler pressure, lbs	180	180	180	180	200
Weight on drivers, lbs	96,800	95,400	96, 800	94,350	94,100
Total weight, lbs	124,000	119,250	123,400	119,325	129,225
Superheating surface, sq. ft	307				

	Engine.	Engine, Miles.	Ton-Miles, Thousands.	Coal, Tons.	Coal, per 1,000 Ton-Miles.	Relative Economy.
May, 1903, to December, 1903	548	34,493	33,183	1,541¾	93	81.5
Freight	482	31,857	30,457	1,741¾	114	100.
January, 1904, to May, 1904	548	16,812	14,404	931	129	74.
Freight	616	15,722	13,248	1,167	176	100.
June, 1904, to September, 1904	548	15,768	2,451	467¾	382	81.5
Passenger	595	16,128	2,560	600	469	100.
	634	16,854	2,750	680¼	495	105.

Engine No.	1000	996 and 997	1300	1319
Type	4—6—0	4—6—0	4—6—0	4—6—0
Kind	Compound S. H.	Compound	Compound S. H.	Compound
System	2-cyl. Schmidt fire tube	Pittsburgh 2-cyl.	2-cyl. Schenectady, fire tube	2-cyl. Schenectady,
Cylinders	22 and 35 x 26	22 and 35 x 26	22 and 35 x 30	22 and 35 x 30
Drivers	63 ins.	62 ins.	62 ins.	62 ins.
Heating surface, fire tubes and firebox, sq. ft.	1,888	2,420	2,492	3,065
Superheating surface, sq. ft.	350		390	
Grate area, sq. ft.	33.02	33.02	44.08	44.08
Boiler pressure, lbs	210	210	200	200
Weight on drivers, lbs	129,000	128,000	141,000	141,000
Total weight, lbs	172,000	169,000	192,000	190,000

and Smith Falls, a practically level division, with rolling grades with a maximum of 0.5 per cent., and the results were as follows: The column marked "Relative Economy," in each case showing the amount of coal consumed by engine No. 548 as compared to the engine with which it was tested. (*See table on page* 272.)

Noting that Nos. 616 and 634 are simple engines and Nos. 595 and 482 are compounds, these results show satisfactory agreements, and would show that this engine consumed about 75 per cent. of the coal required by a simple engine, and 82 per cent. of that required by a compound in similar service. The superheat obtained in this engine is, however, high, running from 550 deg. to 650 deg., according to conditions, and it may be considered as representing the extreme limit to which superheating can be conveniently carried. There is no doubt that the results that have been obtained are exceptionally economical, and the engine has been a favorite with the men handling it in any service. The valve and cylinder arrangements of this engine were designed by Mr. Schmidt and have given entire satisfaction at the temperature mentioned above, although when the superheat was raised above 700 deg. a certain amount of trouble was experienced with the lubrication and packings.

The results from engines 1000 and 1300 extend over a period of nine and eleven months, respectively, during which time these engines were compared with engines identical in every respect except that of not being equipped with a superheater. The dimensions of these engines are given at the foot of page 272.

Engine 1000 was compared with Nos. 996 and 997 for periods in which they were running in corresponding service between Montreal and Smith Falls in freight service. Engine 1300 was compared with No. 1319 in corresponding service between Chalk River and North Bay, and North Bay and Cartier; these divisions are very similar, Chalk River to North Bay being an undulating road with several grades four to seven miles long, with occasional stretches of 1 per cent., but more generally 0.6 to 0.8 per cent., the total rise on the division being 135 ft. From North Bay to Cartier the road is undulating, except for one rise of 480 ft. in sixteen miles, the limiting grades being 1 per cent. and the total rise 220 ft. The results were as follows, arranged as for engine No. 548:

	Engine....	Engine, Miles.....	Ton-Miles, Thousands..	Coal, Tons.....	Coal, per 1,000 Ton-Miles.....	Relative Economy...
Montreal to Smith's Falls.						
January, 1904, to July, 1904.....	1,000	21,567	25,321	1,271½	100	72
	997	19,662	23,278	1,499¼	129	100
August, 1904, to September, 1904	1,000	3,740	4,657	188½	81	70
	996	5,666	7,026	409¾	116	100
Chalk River to North Bay.						
November, 1903, to September, 1904	1,300	22,987	17,075	1,127½	132	90
	1,319	19,983	15,091	1,112½	147	100
North Bay to Cartier.						
November, 1903, to September, 1904	1,300	10,964	9,887	550½	111	84
	1,319	10,521	9,249	616½	133	100

These results are rather more favorable to the superheater engines than would have been expected, especially in the case of engine 1000, where it will be seen that this engine gave considerably better comparative results than No. 1300. These engines also being equipped with the smoke-tube type of superheater, did not obtain the same degree of superheat as No. 548, generally running from 500 deg. to 550 deg. There was a certain amount of leakage from the boiler of 1000, 996 and 997 class during the period, which makes the comparison of less value than those for 548 and 1300, but in spite of this the results are evidently satisfactory.

The results from twenty Schmidt smoke-tube superheaters and twenty-one Schenectady superheaters have been obtained over a period of four months.—[See original paper for these figures.—EDITOR.]

GENERAL CONCLUSIONS.

The use of superheated steam does not entail the multitude of practical difficulties that so generally accompany any invention or improvement that is introduced to improve the economic results obtained from a locomotive, and, indeed, it is probable that as experience with its application develops, some of the expenses that are incurred in the locomotive of to-day will be diminished rather than increased. There would only appear to be two possible sources of additional cost, the wear of valves and cylinders due to defective lubrication, and the cost of maintaining the superheater itself. So far as has been learned at present, the lubrication of superheater engines is not different from that of other engines, with the exception that the lubrication must be accomplished, and it is not sufficient to hope that the oil gets to the designed spot. For this purpose a positive feed lubricator is required, and this should preferably be provided with six feeds, so that pipes may be led to each end of the valve and to the cylinder. It should also be possible to vary considerably the amount of oil fed per minute, as superheater engines, even more than those of the ordinary type, require more oil when working slowly at long cut-offs than at other times, on account of the high temperature of the steam being maintained throughout the stroke. This can be effected either by supplementary oiling or by an easy adjustment

	Engine....	No. of Class Running...	Ton-Miles, Thousands..	Total Coal, Tons.....	Coal per 1,000 E. G. Ton-Miles..	Relative Economy... 1600 to 1621.....
Megantic to Farnham.						
January.....	1200	6	759	124¾	328	100
	1621	7	13,585	2,164½	318	97
February.....	1200	4	879	177¼	403	100
	1621	7	12,639	2,060½	326	81
March.....	1200	1	170	32	378	100
	1621	8	15,481	2,153¼	278	74
April.....	1200	1	1,033	152¼	295	100
	1621	8	13,923	1,820¼	261	89
Farnham to Outremont.						
January.....	1200	8	1,120	126¼	225	100
	1621	4	1,800	186	206	92
February.....	1200	4	1,754	211	240	100
	1621	7	801	105½	263	109
March.....	1200	2	1,228	112½	183	100
	1621	3	821	83	202	110
April.....	1200	1	49	5½	224	100
	1621	1	52	6	230	102
Newport to Farnham.						
January.....	1200	4	611	102¼	334	100
	1621	6	1,807	261¼	289	87
February.....	1200	2	946	137	289	100
	1621	4	1,184	177¾	300	104
March.....	1200	2	1,036	148¼	286	100
	1621	1	282	37¼	264	92
Brownville to Megantic.						
January.....	1200	12	5,364	677	252	100
	1621	6	12,113	1,429¾	236	94
February.....	1200	12	6,991	982½	281	100
	1621	6	4,686	801¾	342	122
March.....	1200	12	7,907	949¼	240	100
	1621	4	9,447	1,064	225	94
April.....	1200	14	6,319	720¼	228	100
	1621	4	7,837	923½	235	103

of the lubricator, allowing a large amount of oil to be fed at low speed, but the latter will be preferable if obtained without complication. With proper lubrication there appears to be no additional wear of valves or pistons, and while a special mixture of metallic packing must be used, it has given, if anything, less trouble on the superheaters than on the other engines. On engine 548, in which the steam was superheated as high as 700 deg., it was found that the ordinary valve oil was not suitable, and that the rod packings would melt out, but by reducing this from 550 deg. to 600 deg., these troubles were not experienced, and no difference is noticed between an operation of this and an ordinary engine. The valves used on the 548 are Mr. Schmidt's design, but with split ring packing in place of the solid ring used in Germany, so that they are practically similar to the piston valves in general use, except in their being of small diameter, 6 ins. for an 18-in. cylinder, and double ported. The packing rings, in place of being narrow, are comparatively wide, and on the surface there are several water grooves. These rings have given exceedingly good service, but in view of the successful use of split rings it is difficult to see any reason why valves of the ordinary design should not be entirely suitable for superheated steam, the only point to consider being whether small double ported valves would not be preferable to the large single ported valves at present in use, and whether wide rings with water grooves would not give better results than narrow plain rings. It is natural that, on account of the reduced weight of the superheated steam, a smaller admission area can be used than that required for saturated steam, but for equal flows under equal heads, the rate is only 10 to 9 and 8, for steam superheated 100 deg. and 200 deg., respectively, so that the dimensions adopted by Mr. Schmidt must be entirely ascribed to the use of double ported valves. Those engines on the Canadian Pacific having smoke-tube superheaters which have not developed the same degree of superheat as engine 548 have given, so far, no trouble with their valves, pistons and packing, when properly lubricated, and while there is room for considerable improvement in positive feed lubricators before an entire suitable design is obtained, it is safe to say that with proper lubrication there will be no greater expense in maintaining the engine on account of using superheated steam.

The repairs to the superheater proper are at present difficult to determine; the smokebox superheater certainly entails an additional expense when flues are renewed, as it has to be entirely dismantled in order to get at the tube sheet, but while it is said to have given some trouble in service in Germany, such has not been the case in three years' experience on the Canadian Pacific Railway. Some trouble was at first experienced with the joint between the large tube and the back tube sheet, but this was overcome by properly thinning the edges of the lap, as in firebox construction. There has been no leakage from the various joints in the front end and, in fact, so far nothing has developed that would lead to any additional expense in maintenance.

The smoke-tube superheaters of the Schmidt type have given no trouble in service, but the arrangement of bolts and clips for securing pipe flanges to the headers is inconvenient, and it is quite difficult to make the joints perfectly tight to commence with; once tight, however, they do not appear to develop leakage, and it seems probable that by the independent bolting now arranged for there will be no difficulty in this respect. In the Schenectady type there has been no trouble with the headers, but the ends of the superheater pipes toward the firebox have blistered in a number of cases, due to the dampers not operating properly and allowing the pipe end to become overheated; this has been overcome by welding a solid plug into the end of the pipes, which should remedy the defect as in the Schmidt design, in which steel return bends are used; this action has not developed, as the metal is suffi-

ciently thick to stand a considerable temperature without deforming when steam is admitted. The dampers must, however, be kept in an operative condition, as otherwise, when the blower is applied with a hot fire immediately after shutting off, the pipes may be subjected to an intense heat which is unsafe in view of their containing no steam. The 5-in. tubes have not been giving any especial trouble; in fact, they have lasted as well as the smaller tubes; this applies, of course, to good water districts, and there is no available experience to determine whether, on bad water, they would stand up until the other tubes need renewal, but it is evident that their position in the flue sheets is favorable and the circulation around them is better than around the more closely spaced fire tubes.

As a matter of fact, it is too early yet to say anything definite about the expense of maintenance of superheaters; there is, of course, a possibility of a comparatively rapid deterioration of the pipes occurring, but there does not appear to be any immediate expense that will develop in one or two years' service. On the other hand, there is the advantage of decreased evaporation for the same work, that occurs in compounds on acount of their increased efficiency, and there is also an advantage in the dryness of the steam and reduced liability of water in the cylinder. On the smokebox superheater with its high superheat, it is almost impossible to work water over into the cylinder, excepting when first starting out before the apparatus has been warmed up, and while this is not the case to the same extent with moderate superheaters, it is an advantage to a certain degree.

A possible advantage of superheating has not been utilized in its application in America, namely, a reduction in boiler pressure without loss in efficiency, although in Germany this has been usual. There is no doubt that the increase of pressure from 175 to 200 and 210 lbs. that has taken place within the last few years has been of doubtful advantage. While there is a gain in economy, this is accompanied by an increase in the losses due to leakage, both in engine and boiler, and by a considerable increase in the cost and trouble of boiler maintenance. By superheating, the initial pressure becomes of less importance, and with the proper amount of superheat it will be possible to return to pressures of 175 lbs. or less without any appreciable loss in economy, and with a relief from those boiler troubles, which have become more serious as the pressure has increased, it is probable that the saving from this cause alone will overbalance any additional expense connected with the maintenance of the superheater.

Herr Garbe, in addition to the reduction of boiler pressue, advocates a still further advance, namely, the enlarging of the cylinders sufficiently to develop the full power of the engine, with cut-offs of 30 to 33 per cent. A reduction in power is then effected chiefly by throttling, the cut-off remaining practically constant. This method may possibly prove advisable in American passenger work, but it does not appear practicable for freight locomotives. It is evidently impossible to develop the same tractive power with a given weight on drivers, with a cut-off of 30 per cent. as with 80 per cent., since there is a greater variation in the maximum effort in the former case, and with the conditions here prevalent, where the loading is so closely equal to the capacity of the engine, a reduction in capacity could not be tolerated. A reduction in boiler pressure, however, when accompanied by a corresponding increase in the cylinder dimensions, does not affect the tractive power, and would appear to be a decided advantage.

In general, therefore, it may be assumed that the maintenance of locomotives using superheated steam will not be necessarily greater than that of ordinary locomotives of similar size, as although certain additional expenses are introduced, these are offset by economies in other directions, and the net result will not be very much different. If this position is correct, the advisability of superheating depends entirely on the relation between the initial additional cost and the saving obtained, and as, at present, the cost of applying a superheater is about $1,000 per engine, and the tendency will be rather to reduce this amount than increase it, it is evidently a very good investment. A 200,000-lb. freight engine making 30,000 miles per annum will burn about 2,500 tons of coal, which, at $2 per ton, costs $5,000, so that evidently a saving of 10 per cent. will pay 50 per cent. of the additional cost per annum, and it appears perfectly safe to state that with a superheater at least that amount can be saved. While slightly more expensive, at first cost, than compounding, there is in the application of superheated steam a possible development in locomotive engines, which obtains at least as great an economy in fuel, which is practicable and without complication in its construction, which costs no extra for maintenance, does not reduce the efficiency of a locomotive in any way as a mover of freight, and which, without any desire to appear too enthusiastic, certainly promises to become one of the greatest steps in the direction of economy that has been introduced for many years past.

Proper Loading for Locomotives.

Committee—C. H. Hogan, H. T. Herr, D. F. Crawford, H. T. Bentley.

This report contained the opinions of a number of individual members as to the essential factors in loading locomotives, and presented a number of references to treatment of the subject in the technical journals. A feature of value lies in references to special articles devoted to this subject.

The important factor underlying the proper loading of locomotives is the length of time which may be used in hauling a train over a controlling section of the road; this controlling section may be an opposing grade, a stretch of single track in an otherwise multiple track line, distance between sidings, etc. As the time may be longer, or shorter, so may the loading of the locomotive be heavier, or lighter. The length of time having been fixed, the next two important factors are the power of the locomotive and the resistance of the train and the items which, in opinion of the members, affect these factors as quoted below.

The power of the locomotive may be calculated with a reasonable degree of accuracy, but without knowing the peculiar conditions of each case it will be impossible to say what allowance should be made for the condition of the locomotives, for the water, the fuel and for the almost innumerable items, some of which need attention in each locality.

The train resistance contains a greater number of variables than enter into the calculations of the power of the locomotive; the number of cars, and their condition, track conditions, atmospheric conditions and others. When the rating is very accurate the total tonnage should be ascertained by more accurate means than those prevailing at the present time in many places.

There is a means of checking the calculations of locomotive power and of train resistance—the dynamometer between tender and first car in train, and it is recommended that this be used. Calculations are very well, but it frequently happens that the basis of the calculations is wrong. For instance, the grades may not be what the profile data show; the elevation on curves may have more serious effect than assumed; the resistance per ton and per car may differ from the assumptions, and the locomotive may give results different from the assumed ones.

The operating department and the motive power department ought to take equal interest in the proper loading of locomotives.

Immediately below are given the factors which the members think affect the economical loading of locomotives, and considering the innumerable combinations of them which are possible, not only on different roads, but also on different sections of the same road, the committee thinks that it cannot treat of the subject of the report in other than the very general way given in the forgoing. The name of the member making reply and the railroad with which he is connected are given:

A. E. Mitchell, Lehigh Valley R. R.—Grades. Curvature. Condition of locomotive. Steaming qualities of locomotive. Quality of coal used. Quality of water used. Location of water stations, whether on up grades or levels. Speed required for fast freight. Speed required for slow freight. Proper distribution of time on time-table, so that faster time can be made on levels and descending grades and slower time on up grades. Condition of cars in each train, whether heavy on side bearings or otherwise. Size of journals under cars. Condition of journal lubrication. Weather conditions. Conditions of track and rail.

William Garstang, C. C. & St. L. Ry.:—Maximum boiler duty that can be depended on, with tonnage confined to a basis of equivalent steam consumption for various speeds. Scheduled speed between terminals. Actual speed necessary to make schedule time. Concentration of tonnage for reduction of flange resistance. Weather and temperature conditions.

T. W. Demarest, Penna. Lines West, N. W. System:—The character of the motive power. Transportation facilities as influenced by: (a) Physical character of the division, having reference to grades and alignment. (b) Whether it is a single-track railroad or a double-track railroad; passing siding facilities and terminal facilities. Density of traffic. Traffic requirements which cover the character of the business, *i.e.*, whether same is a low-class business on which a fast movement is not required, or whether it is a high-class business in which speed is one of the vital requirements. Each division of a system must receive individual analysis with above factors in view. The analysis for one division may or may not apply to the other divisions of a railroad; in general it will not. A further factor, of course, is such motive power facilities as will insure the prompt handling of the locomotives at terminals with a view of increasing the service hours for transportation purposes, and we, finally, have four conditions to be obtained: 1. Maximum service hours for the locomotive. 2. Maximum miles per hour for the locomotive considered as being available for transportation service for each hour of the entire month or year. 3. Maximum miles per hour for the locomotive while available for transportation purposes 4. Maximum tons per train for each individual train.

J. A. Carney, C. B. & O. Ry.:—The proper loading of a locomotive is the number of tons of train it can put in and get out of side tracks in a reasonable length of time and haul up maximum grades without doubling, either by running for the grade, if it is short and a stop is not necessary at the foot of the hill, or by a straight pull if the grade is long or a stop necessary at the bottom. The weight of the train should vary with the number of cars. Theoretical figures on tonnage rating per tractive force are not reliable, and while they furnish valuable data to base rates on, the local conditions may make them too low or too high. Actual service tests based on theoretical rating give the best results. On a level road the theoretical rating is generally too high and on a hilly road the theoretical rating may be too low where the maximum grade limits the tonnage rating.

W. R. McKeen, Jr., Union Pacific R. R.:—R. Resistance in pounds per ton of train. V. The miles per hour. T. The tons in train. L. The length of train. C. The number of cars in train, surface exposed to wind. The correction of temperature is an important one where the temperature varies from 20 degrees below zero to 105 degrees above zero. The correction for wind is an important one, particularly in level country on the plains where the wind is almost constant and more important than the grade resistance. If curves are not compensated the same afford a factor for correction. The drawbar pull of the engine is dependent upon so many variable quantities and so many quantities upon which it is almost impossible to estimate that it would seem the engine capacity should be determined by means of a dynamometer car which would avoid any discussions as to the limit of same.

A. E. Manchester, C. M. & St. P. Ry.:—In my opinion no hard and fast rule can be laid down covering the proper loading of locomotives, except that all of the local conditions in connection with the service be taken into account.

J. F. Walsh, C. & O. Ry.:—Taking it for granted that a locomotive will not be started over a division unless in probably such condition as will enable it to make a successful round trip, I would say that weather conditions would be the only thing that should affect its hauling capacity; the latter can usually be approximately

determined by multiplying the tractive power by the number of thousands of pounds upon the drivers. This rule, we find, will give approximately what a locomotive can haul over a straight level track. In figuring on the resistance due to curvature, we figure that each degree of curvature is equal to a rise in grade of 1⅓ ft. per mile. To determine approximately what an engine will haul up a given grade, we take ⅜ of the number of feet rise in grade per mile, divide that sum into the tractive power, and that will give approximately what an engine will pull up a given grade. Our tonnage rating is determined by actual pulling tests.

G. L. Fowler, Consulting Engineer:—1. Train resistance. 2. Drawbar pull. The factors affecting the first head include the journal friction, air resistance, grades and number of axles in the train. The second varies with the tractive power of the engine and the condition of the rail. In order, then, to allow for the variations in these factors, I would suggest the lading should be so proportioned that, with the train resistance at a maximum, and the drawbar pull at a minimum, the engine should still be capable of taking its load over the ruling grades. That this may be done and still secure the maximum available load behind the tender, the weight of the trains should be adjusted on a sliding scale in such a way that the tonnage can be increased as the number of axles is decreased. In other words, so that the greater the capacity of the cars the greater the total tonnage.

J. H. Watters, Georgia R. R.:—The factor that affects mostly the economical loading of a locomotive is the one of overloading. A locomotive to do the best work and to show the most economical operation should be loaded with a train with which it can make schedule time over the heaviest part of the road.

C. H. Doebler, Wabash R. R.:—Weather conditions, rail conditions, the ruling grade, time required between terminals, number of trains to be handled over a given piece of track, distance between sidings and distance between coaling and water stations.

A. R. Kipp, Wisconsin Central Ry.:—The economical loading means the minimum cost to haul one ton one mile and is affected by: Wages, including those of enginemen, trainmen and roundhousemen. This item is more important on single-track roads than on double-track roads, as heavily loaded slow freights are more likely to affect other trains than those on double track. This item is controlled considerably by overtime. Fuel: There is an economical limit in the consumption of fuel beyond which the expense of operation rapidly increases. Locomotive repairs. Number of ton-miles hauled in a given period of time. This involves a question of investment in locomotives and car equipment and the amount of money earned with that equipment.

J. J. Conolly, D. S. S. & A. Ry.:—1st. Condition of locomotive. 2d. Quality of fuel used. 3d. Weather conditions.

E. B. Thompson, C. & N.-W. Ry.:—Moving as much freight as possible. Time. Length of division. Weather.

E. W. Pratt, C. & N.-W. Ry.:—Dynamometer tests. Condition of power. Time. Length of division. Condition of coal and water. Weather.

John Heath, C. & N.-W. Ry.:—The basis of rating should be the dynamometer car.

F. G. Benjamin, C. & N.-W. Ry.:—The fundamental principle of loading a locomotive should be based on the question of the most economical load that an engine can haul without the loss of wear and tear on the locomotive, the loss in consumption of fuel and the shortest time on the road. There is no question but what there is good economy in loading an engine to a point where there is a reasonable percentage of reserved power to enable it to handle a train over the heaviest grades and have a measure of reserve to take advantage of inclement weather and high winds; also to take advantage of the road.

T. J. Cutler, Northern Pacific Ry.:—1st. The weather condition. 2d. Speed over the division. 3d. Time on road in regard to overtime paid. 4th. The volume of business and the amount of power available. 5th. The length of passing tracks on the division.

LOCOMOTIVE DRIVING AND TRUCK AXLES AND LOCOMOTIVE FORGINGS.

COMMITTEE.—F. H. Clark, J. E. Sague, S. M. Vauclain, L. R. Pomeroy, F. W. Lane, E. B. Thompson.

Your committee appointed in 1902 to draw up specifications for locomotive driving and truck axles and locomotive forgings, with instructions to defer our final report until after the Washington meeting of the International Railway Congress, has carefully considered the recommendations and discussion of our meetings of 1903 and 1904, and now presents the amended specifications given below for your consideration and approval. Your committee has conferred with representatives of the American Society of Mechanical Engineers and with members of Committee "A" of the American Society for Testing Materials, and a compromise specification suggested which we believe will be satisfactory to each organization, except as noted below for this Association. This compromise specification involves a change in the reduction of area from 35 per cent., as originally recommended by this committee, to 25 per cent. It also involves the bending test covered in our last report, specifying a 1 by ¼ in. test piece bent cold, 180 deg., over a bar 1 in. in diameter. This test is recommended by both the American Society of Mechanical Engineers and the American Society for Testing Materials. Your committee, however, feels that it is not desirable, as it is hardly possible to get a 1 by ½ in. test piece without drilling a larger hole than we would care to recommend, and we believe further that the bending test is not essential, but that the information that would be derived from such a test would be more satisfactorily covered by the requirements for elongation and reduction of area. If, however, the members of the Association feel that the bending test should stand we will not object to having that test included in the specifications, but would suggest in that case the desirability of making the test piece ½ in. square, instead of 1 by ¼ in. in section.

We wish to again call attention to the manner of taking the test piece by means of the tools described in our progress reports of 1903 and 1904, and especially to the drill submitted by Mr. J. F. Kincaid, of the American Locomotive Company, in the discussion of the report of 1904; also to the arguments in favor of the test piece taken by means of a hollow drill, which for convenience are restated below:

1. The physical test outlined is one which should insure proper hammer work.
2. It does not show the manufacturer which axle is to be selected for test.
3. The axle tested is not destroyed, but is available for use if it meets the requirements.
4. The test may be used in the purchase of small lots, most orders from railroad companies being for from six to ten axles.
5. The test does not require a discard and in no way adds to the cost of the axle.
6. It furnishes the manufacturer with a check of the work done in his plant.
7. The test is one largely used by the United States Government for forgings.

The members of your committee feel that these specifications shown below will insure good material, and recommend that the specifications be adopted and the committee discharged. [The recommendations will be printed in full in the proceedings of the Association.—EDITOR.]

SHRINKAGE ALLOWANCE FOR TIRES.

Committee—F. J. Cole, J. E. Muhlfeld, A. S. Vogt, W. A. Nettleton.

The work assigned your committee was as follows: "To consider whether the present shrinkage allowance, 1-80 in. per foot, is sufficient for large-diameter wheels with cast steel centers."

We would recommend that the present shrinkage of 1-80 in. per foot in diameter be retained for all centers of cast iron and cast steel less than 66 ins. diameter, but 1-60 in. per foot in diameter be used for cast steel and cast iron centers 66 ins. and over in diameter.

From the replies received, correspondence and discussion among the members of the committee, the consensus of opinion is that the design of wheel centers, especially those of cast steel and of large diameter, has much to do with the question of loose tires. Your committee, therefore recommends that this question, including suggestions for preferred sections of spokes and rims, numbers of spokes, etc., would bear further investigation, which it might be desirable to refer to another committee.

That tires are rolled out or stretched when worn to, say, about 2¼ ins. in thickness has been confirmed by very careful measurements made of the tires after removal. The consensus of opinions and replies indicates that most of the difficulty experienced from loose tires occurs when they are worn to thicknesses varying from 1⅜ ins. to 2¼ ins.

Loose tires are also caused by light cast steel centers of insufficient section of spokes and rims to resist the shrinkage of the tire. This may also be occasioned by the distance between hubs being too great, requiring the spokes to be dished. In such cases, when the tire is shrunk on, the wheel center will be dished. The suggested standard distance between hubs on locomotives for standard gauge is 55 ins. This allows the use of straight spokes.

Broken tires are often caused by bad shimming when tires become loose and shims and liners are used, which only partially cover the circumference of wheel center and do not butt against one another, but leave spaces several inches in length. The tire is unsupported at these points, and repeated transverse bending stresses are caused at each revolution of the wheel. Broken tires are again caused by too much shrinkage caused by improper gauging, and too much emphasis cannot be placed upon the necessity of providing a first-class system of gauges, both for boring tires and turning off wheel centers. These should be referred to master gauges from time to time, to insure their accuracy.

A very large number of passenger locomotives in use have driving-wheel centers 72 ins. in diameter. The Master Mechanics' standards are 70 ins., 74 ins., etc., and we would recommend including 72 ins. diameter among the number of standard sizes. The use of this size at the present time would warrant its recognition.

The Pennsylvania Railroad has used 1-64 of an inch per foot in diameter for a great many years for all sizes of wheel centers, both cast iron and steel.

The suggestions of the committee are summarized as follows:

Shrinkage 1-80th of an inch per foot in diameter for cast iron and cast steel centers less than 66 ins. in diameter.

Shrinkage of 1-60th of an inch per foot in diameter for centers 66 ins. and over in diameter.

Minimum thickness of tires should be established, due consideration being given to the diameter, service and weight per wheel.

Tire and wheel gauges should be of good design, heavy enough to resist bending and subject to frequent inspection to insure accuracy.

Seventy-two ins. diameter of wheel center should be included in standard sizes.

Wheel center rims should preferably be uncut, but, if cut, slots should be machined out and closed with solid cast iron liners driven in. No lead or white metal to be used.

LOCOMOTIVE TESTS OF PENNSYLVANIA RAILROAD AT ST. LOUIS EXPOSITION.

COMMITTEE.—F. H. Clark, H. H. Vaughan, C. H. Qureau.

The members of your association, appointed in 1903, at the request of the Pennsylvania Railroad System, to serve on their advisory committee in connection with the locomotive tests to be undertaken at St. Louis, report that the tests of eight engines were completed, and that the data have been worked up and will soon be in the hands of the printers. It was found impossible to test the many engines as was intended, owing partly to delays in the arrival at St. Louis of a part of the testing plant equipment, and partly to unexpected difficulties in breaking in the plant.

We feel that the members of this association are more or less familiar with the work done on this plant and appreciate the

earnest and careful work done by the staff of the Pennsylvania Railroad engaged on these tests, but your committee wishes to record its appreciation of the energetic and thorough method in which the tests have been carried out, and to call attention to the immense amount of work involved in working up the data obtained.

It was not to be expected that in the limited time available it would be possible to settle all of the important problems of locomotive design in which we are so much interested, but we believe that a careful analysis of the final report will indicate that a great deal has been done in this direction, but that more perhaps has been accomplished in the direction of suggestions for future work and investigations. The report of the committee will probably be published in three or four months.

MASTER CAR BUILDERS' ASSOCIATION.

ABSTRACTS OF REPORTS.

Brake Shoe Tests.

Committee—Charles Coller, William Garstang, W. F. M. Goss.

This report presented the results of tests on four brake shoes submitted to the committee and tested on the M. C. B. Association brake shoe testing machine at Purdue University. After recording results the report concludes as follows:

"As evidence of progress in brake shoe construction, your committee would call attention to the high frictional qualities of the shoes tested this year, as set forth in the preceding paragraphs, and to the fact that in improving their output manufacturers make frequent use of the association's machine. Work of this nature does not formally come to the attention of your committee. It is reported, also, that one manufactory is installing for itself a testing machine designed after that of the association."

Triple Valve Tests.

Committee—W. McIntosh, F. M. Scheffer, W. S. Morris, C. A. Schroyer, A. J. Cota.

It is probable that the coming year will require considerable work from the triple valve committee, as there are some remarkably interesting developments taking place in that line, and if the new devices some of us have had the opportunity of seeing perform on the testing rack prove as efficient in service, we may look for almost as much of a revolution in brake efficiency in the immediate future as there was when the automatic brake superseded the straight air brake. With this in view your committee would recommend the continuance of the triple valve committee, and that it be carefully selected to meet the prospective conditions; its members, so far as practicable, to be skilled in air brake matters, and instructed to confer with the Air Brake Association.

Draft Gear.

Committee—Le Grand Paris, E. D. Bronner, W. F. Kiesel, Jr., G. W. Smith, Mord Roberts.

The committee would recommend that the 1-in. total side clearance shown on M. C. B. Sheet "B" be increased to 2½ ins. total clearance. Would also recommend that experiments be made to determine how much more clearance can be safely used without the use of a centering device.

In view of the fact that the work of the draft gear committee is now so closely allied with that of the coupler committee, it does not seem that there is any use to continue the draft gear committee under present conditions. If it is not the desire of the association that the committee should take up the question of testing new designs, as was done several years ago, or improvement in old designs, it would probably be well to discharge this committee or merge it with the coupler committee.

Doors.

Committee—J. E. Keegan, W. E. Sharp, T. Treleaven, J. W. Muncy, D. Van Alstyne.

Your committee feels that the members are not particularly interested in the subject assigned, as shown by the very limited number of replies received and the meagre information brought out in answer to the circular of inquiry issued, and has no recommendations to make as to the revision of the drawings of outside door as shown in M. C. B. Sheet "F," or for suitable grain doors to meet the requirements of large capacity cars.

The American Association of Local Freight Agents, through its conference committee, submits a resolution adopted at the annual convention of that association at Peoria, Ill., in June, 1904, as follows:

"*Resolved*, That it is the sense of this association that better results would be secured if doors of 6 ft. in width be made the standard for all ordinary box cars, and that the matter be referred to the incoming conference committee with a view of obtaining such a standard through the Master Car Builders' Association."

The conference committee submits the question for consideration and action, believing that the adoption of standard width of 6 ft. for all ordinary box-car doors will promote the interests of trade and railway traffic in general.

Subjects.

Committee—J. S. Chambers, F. T. Hyndman, O. M. Stimpson.

SUBJECTS FOR COMMITTEE INVESTIGATION DURING THE YEAR 1905-1906.

1. A Standing Committee on Car Wheels. The Committee on Subjects deems this subject of sufficient importance for a committee to report from year to year on all subjects pertaining to design and specifications of cast iron wheels.
2. The use of metal in passenger equipment car construction. A committee to report on the advisability of the use of metal in passenger equipment car construction.
3. Brake Beams. A committee to prepare and submit specifications and tests for brake beams for 60,000, 80,000 and 100,000 lb. capacity cars.
4. Bolsters. A committee to prepare and submit specifications and tests for bolsters for 60,000, 80,000 and 100,000 lb. capacity cars.
5. The use of four-wheel versus six-wheel trucks for passenger service.
6. As to the efficiency of the different designs of side bearings.
7. Investigation of damage to cars, due to switching; including "Hump-yards."
8. The use of cast steel and wrought iron in car construction and their limits.
9. Pressed steel shapes in passenger car design.
10. The use of truss rods in passenger equipment cars.

Stenciling Cars.

Committee—H. M. Carson, J. S. Lentz, Jos. Buker, G. T. Anderson, W. F. Bentley.

Your committee has confined itself to the subject of stenciling freight cars, believing, if a general agreement can be reached upon this important subject at this time, that much good and economy will result. It will be noted that your committee has confined itself to the following recommendations:

First. The style of letters and figures to be used so that uniform stencils may be prepared and used on all freight cars.

Second. A uniform height of letters and figures for certain specified markings, so that in a general way these markings shall be uniform on all freight car equipment.

It will be particularly noted that the committee does not recommend the location on the car for the various markings, believing that each road desires more or less discretion in this respect, and also for the reason that this would be a very difficult matter at this time, on account of the various new types of steel car equipment being introduced, which will not permit the same location for similar markings as on the old wooden equipment they are superseding.

It will further be noted that the committee does not confine its recommendations for the height of letters to any one specified height, as a general thing, and in endeavoring to recommend certain limits for height for different markings, hopes that a general agreement within these limits may be arrived at. In recommending six sizes only for the heights of letters and figures, your committee believes that it has fairly covered the ground and given a choice which may be accepted by every one. Designs have been submitted for the type of Roman letter, which, it is trusted, will meet with general approval. The designs submitted are for the 7-in. letters and figures only. If these designs are accepted with the report by the convention, it is the purpose of the committee to prepare designs for the various other sizes of letters and figures recommended in the report and submit them for adoption as recommended practice by letter ballot.

First. It is recommended that the Roman letters and figures of the designs shown in the attached drawings be adopted for uniform stenciling of freight cars.

Second. It is recommended that the sizes of these letters and figures shall be confined to the following heights: 1 in., 2 ins., 3 ins., 4 ins., 7 ins. and 9 ins.

Third. It is recommended that 7-in. or 9-in. letters or figures be adopted for the initials or name and numbers for the sides of cars, and 4-in. letters or figures for the same markings on the doors and ends.

Fourth. It is recommended that for other car body markings on sides and ends, such as capacity, couplers, brake beams, class of car, date built, outside dimensions, inside dimensions and markings inside of car, 2-in. or 3-in. letters and figures be used, with the following exceptions:

1. All weight marks should be 3-in. or 4-in. letters or figures.
2. Trust marks, patent marks, and other private marks, should be 1-in. letters and figures.

Fifth. It is recommended that all marks on trucks should be confined to 1-in. and 2-in. letters or figures.

Sixth. It is recommended that stenciling on air brake cylinders or reservoirs should be 1-in. letters or figures.

It will be noted that the above recommendations of your committee conflict to a certain extent with the recommendations for stenciling certain markings on cars, adopted in 1896 and shown on page 451 of the 1904 Proceedings, in that certain letters containing fractional sizes are there recommended; and as it is a distinct recommendation of this committee that all fractional sizes shall be omitted, your committee would recommend that recommendations referred to be changed to conform to the committee's report. Furthermore, the design of stencil is shown in the report referred to for the A and B end of freight equipment cars, these letters being 1½ ins. in height and the circle 2¾ ins. in diameter. Your committee recommends that the relative proportion for these stencils be adhered to, but that the height of letter be increased to 2 ins., diameter of the circle being in proportion to the increase in size of letter.

In making its investigations your committee has found that very little uniformity exists in regard to the size and design of letters and figures of different sizes on any railroad, one shop a very short distance from another one on the same road often using stencils for the same letters and figures which materially differ from those used at the other point. It therefore seems extremely desirable at this time that some definite agreement be reached by this association, particularly in view of the proposed renumbering of freight car equipment on all railroads, and it is with the object of having some uniformity arrived at this year that your committee submits this report, which, while leaving some parts of this subject uncovered, particularly the location of the various markings, should at least be a long step in advance in obtaining uniform practice.

(Additional reports will appear next month.)

BOOKS.

Manual for Engineers. By Charles E. Ferris. Fifth edition. Published by the University of Tennessee, Knoxville. Price, 50c.

This small manual contains a number of valuable tables and other data, covering a wide range of engineering subjects, and while its real object is to increase the interest of men of affairs in technical training, it will be found very valuable for reference by engineers.

Boiler Room Chart, by George L. Fowler. Published by the Norman W. Henley Publishing Company, 132 Nassau street, New York. This chart shows an isometric perspective, the interior of a modern boiler room, including all of the mechanism belonging to it. It shows water-tube boilers, automatic stokers, feed water heaters and pumps, piping and all of the features necessary to a boiler room, with a list of over 200 parts numbered and named. It is similar in plan to locomotive and car charts, with which the readers are familiar.

Automobile Pocket Book, by E. W. Roberts, author of the Gas Engine Hand Book; Pocket Size, illustrated, published by the Gas Engine Publishing Company, Goodall Building, Cincinnati, Ohio. 1905, price $1.50.

This little book is intended for the use of those who own or operate automobiles. It presents clear and concise information on the care of the machinery, devoting special attention to the engine. While it is elementary and is intended specially for those who know nothing about machinery, it contains information of special value for all who have to do with automobiles, whether they are familiar with machinery and gasoline engines, or not.

Plain and Spherical Trigonometry. By P. A. Lambert, assistant professorof mathematics, Lehigh University, and H. A. Foering, head master of the Bethlehem Preparatory School. The Macmillan Company, New York, 1905.

This book is evidently intended as a text-book. Its plan is to show the relationships between trigonometric functions in such a way as to develop the student's ability to think them out and apply them. The functions are defined by means of projections which have become familiar to the student through geometry. The book contains no tables of functions. The work will lead the student to reason rather than memorize. It contains many examples for practice.

PERMANENT WAY INSTITUTION; JOURNAL AND REPORT OF PROCEEDINGS. Published by the institution, 9 Grace Church street, London, E. C. Edited by Clement E. Stretton, Leicester, England. This pamphlet is to be issued monthly and devoted to the engineering department of railways, including all that appertains to way and works. The editor announces a number of papers on hand for publication, and the journal will be valuable in recording progress in the engineering work of British practice. This number contains papers on pile driving in connection with foundations, coal working under a railway, the training and position of the plate layer, and in addition a list of members and reports of council meetings.

High-Speed Tool Steels. By L. P. Breckenridge. Circular No. 1 of the University of Illinois Engineering Experiment Station.

This bulletin gives a brief account of the development of the high-speed tool steels, and announces a series of investigations which are to be made to determine the most economical speeds at various feeds and depths of cuts for different materials and different sizes of tools, and also to determine the effect of different angles of rake and clearance on the power required to drive the tool. For the present, tests will be made on various grades of cast iron. The circular contains several tables, giving the tabulated results of the most important experiments with these steels which have been made by various authorities. Copies of this circular may be obtained by addressing the Engineering Experiment Station, Urbana, Ill.

Electric Railways. Theoretically and Practically Treated. By Sydney W. Ashe and J. D. Keiley. 285 pages, 172 illustrations and 7 large plates. Published by D. Van Nostrand Company, 23 Murray street, New York. Price $2.50.

This volume treats of the rolling stock only and is intended for use in technical institutions and as a general engineering reference book for those interested in this subject. In addition to the consideration of the design and construction of the cars, there are chapters on the analysis of train performance, train recording and indicating instruments, electric locomotives and electrical measurements. This book is especially valuable because of the thorough treatment of the subject and the fact that the most recent developments are considered although it is to be regretted that more complete details of the electric locomotives could not be presented.

Cement and Concrete. By Louis Carlton Sabin, B. S., C. E. McGraw Publishing Company, 114 Liberty street, New York. Cloth, 507 pages. $5.00.

Though several comprehensive and valuable works upon reinforced concrete have recently appeared, Mr. Sabin's book is the first to come to our attention in which plain concrete is treated with equal fulness. In pursuance of the expressed purpose of its author to place in one volume a connected story of the properties and use of cement, Part I. is devoted to the classification and manufacture of cement, Part II. to the properties of cement and the methods of testing, Part III. to the preparation and properties of mortar and concrete, and Part IV. to the uses of mortar and concrete. Of these sections, Parts II. and III. are most timely, since Part I. is brief and conventional, and Part IV. consists in the main of a discussion of the uses of reinforced and plain concrete, a subject essential to the complete development of the scheme of the book and in itself excellently treated, but which can be found more fully discussed in other works. Among the features of the book which deserve special attention are the chapters upon the testing of cement, and the chapter upon the methods and cost of concrete making, both of which subjects are treated more completely and carefully than in any other work with which we are familiar. The results of a large number of interesting tests and studies are given, and these alone would make the book worthy of purchase by engineers and concrete makers, even were they unaccompanied by the valuable descriptive and explanatory text.

A Treatise on Concrete, Plain and Reinforced. By Frederick W. Taylor and Sanford E. Thompson, with chapters by R. Feret, W. B. Fuller, and S. B. Newberry. John Wiley & Sons, 43 East 19th street, New York. Cloth, 588 pages. Price, $5.00.

This is the most scientific and exhaustive treatise upon concrete which has yet come to our knowledge, and great credit is due to Messrs. Taylor and Thompson for their careful and painstaking labor, evidence of which is displayed throughout the book. In addition to giving the results of their own extensive studies and research, the authors have greatly increased the value of the work by adding chapters from the pens of the well-known authorities mentioned above, and by obtaining their co-operation, as well as that of others, in the examination and criticism of all the important subjects presented. Besides providing for the needs of the student and the expert, the book is also admirably adapted to serve those who wish to find in brief and concise form directions for exact methods of procedure in making and laying concrete, special attention having been given to the needs of such readers. The book has too many valuable features to permit us to mention them all, hence we shall have to content ourselves with referring to only a few. Chapter I., entitled "Concrete Data," consists of a collection of facts in highly concentrated form, many of which have hitherto been obtainable only through a considerable study of numerous books and periodicals. Page references are given throughout this chapter, so that the reader may quickly find the discussion upon which any particular fact is based. The chapters dealing with the composition and testing of cement, including that by Mr. Newberry upon its chemical composition, are very thorough. Chapter XI., by Mr. Fuller, on "Proportioning Concrete," is notable for the new methods presented. If his conclusions are verified by the work of other engineers, they are likely to be of great value in rationalizing the method of proportioning. Mr. Feret gives in Chapter XVIII. the result of extended studies upon the action of sea water upon concrete. The theory and practice of reinforced concrete are treated at some length; simple formulæ are derived, and their application made easy by the insertion of tables of constants. The book is copiously illustrated, and the results of many hitherto unpublished experiments are included. It is our belief that this book will be for some years to come the most complete treatise upon concrete to be found in the English language. We advise all those interested in the subject to add it to their libraries and to study it carefully.

The Principal Professional Papers of Dr. J. A. L. Waddell. Edited by John Lyle Harrington, Civil Engineer. Published by Virgil H. Hewes, 245 West 107th street, New York City. Cloth, 991 pages, $5.00.

The greater portion of this bulky volume consists of a reprint in chronological order of Dr. Waddell's well known papers upon structural design, and the ensuing discussion in engineering pub-

lications. There are also included several articles upon railroad engineering, a number of essays upon engineering education, and various addresses delivered before the students of engineering colleges. A number of the papers included, notably "Some Disputed Points in Railroad Bridge Designing," "The Compromise Standard System of Live Loads," and "Elevated Railroads," were at the time of their publication productive of very thorough discussion by eminent engineers, hence a collection of these papers and discussions in one book presents, in a way, a history of recent development in this country of the design of framed structures. For this reason alone the book should be of value to younger engineers, and to engineering students, many of whom are not likely to ever acquire the publications in which the original articles appeared. To this same class of readers the addresses to engineering students will appeal strongly, as they are full of good advice upon practical questions from one well fitted to give such advice. The paper entitled "The Kansas City Flow-Line Bridge Repairs" is also particularly well adapted to such readers, as it presents fully the method of solving a serious problem in a limited time, a subject not treated in text books and seldom discussed in print. The articles upon engineering education are well worth serious attention by educators, though we are afraid that a general acceptance of some of the views therein presented is somewhat doubtful. The book is admirably edited, most of the papers being prefaced by editorial comment which is so well written and which shows so thorough a comprehension of the problems discussed as to form, in most cases, a valuable addition to the paper which it accompanies. These comments are also of value in putting the reader into the proper focus for studying some of the older papers.

The Uses of Hydraulic Cement. By Frank Harvey Eno.

This book is Bulletin No. 2 of Fourth Series of the Geological Survey of Ohio, and is published under the authority of the State. It opens with a statement that it "deals with the uses of hydraulic cement, a subject on which much accurate information is in existence, though not well distributed among those who have most need of it." Also, "while not the record of new and exhaustive researches" "to any important degree," "it has been the aim to present the facts," etc., in a "simple and clear manner," and it suggests that "in all the vast literature of the subject no other work yet accomplishes this simple purpose." This statement by the State geologist of the work of Professor Eno seems a fair presentation of the matter. The subject is treated in the following order: A brief history of cement; the uses of cement in mortars; the uses of cement in concrete; specifications for concrete materials; machinery and tools. The chapter on the uses of cements in mortars is taken up under headings, the most important being as follows: Development; advantages of cement in lime mortar; natural vs. Portland cement; effect of various sands on strength; effect of water on strength; permeability of cement mortar; effect of loamy sand upon mortar; colored mortars. Other headings of special interest are: Cement hardened quicksand; effect of freezing upon mortar; effect of heat upon mortar. The chapter on the uses of cement is also taken up quite fully, walls, abutments, culverts being among the headings, as also monolithic concrete houses, concrete block houses, sea walls, water pipes, tunnels, ties and rail beds, sidewalks, posts, telegraph poles. "The uses of cement in reinforced concrete" necessarily treats of things new, and needs to be up to date, and seems to be efficient in this particular. The description of various systems includes Monier, Roebling, expanded metal, Melan, Thacher, Hennebique, Ransome, Weber, Kahn, Columbian Cumming, De Man, and Luten. Concrete piles are touched upon, special note being taken of the Cushing, Raymond and Hennibique forms. Many pages are given to specifications for cement or concrete in various forms, and the final chapter takes up machinery and tools, crushers, screens, mixers and others. The book is profusely illustrated, and contains a number of tables. It neither does, nor pretends to do, much on the theoretical or mathematical side of the subject. It is a very creditable production. Nearly every engineer knows something of parts of what the book covers, but there are few who cannot find considerable that is new and well worth while among the many things contained in its 247 pages.

The Strategy of Great Railroads. By Frank H. Spearman. New York: Charles Scribner's Sons.

Usually the author of a book states its purpose in a preface. In the present instance there is no preface, so that the reader must infer its scope and objects from the contents. It consists of a series of articles in which are described the origin and originators, the locality occupied, the sources and character of the traffic, the managers, management, and operation of eleven of the great railroad systems of the country. These are the New York Central, Pennsylvania, Harriman and Hill Lines, Wabash System, Gould lines, Rock Island System, Atchison, Topeka & Santa Fe, Chicago, Milwaukee & St. Paul, Chicago & Northwestern, and the Chicago & Alton systems. Accompanying each of the articles is a map, showing the location of the main lines and all their ramifications. About twenty pages of large type are devoted to each, so the descriptive matter is necessarily brief and, happily, is concise. It may be said that any one wanting to get a general idea of the extent, location and traffic of the great railroad lines of the country can do so more quickly, and with the expenditure of less time and labor—and more agreeably, too—from this book than he probably could from any other source. Generally, what is said in it is laudatory and commendation of the lines, their officers and their management. There is little or no criticism of any of these, and the book reads as though the author wrote with free passes in his pocket. But it is impossible to go through the book without being interested in it, although there is a kind of hustling tone about some of the writing which, at times, rouses dissent and excites the reader to pencil interrogation marks on the margins. The execution of the maps, however, cannot be classed among its lesser deficiencies. In the production of some of them the main idea in the mind of the draughtsman must have been that the shortest distance between two points is a straight line, and all of them have the fault of the diagrams published in railroad guides and folders, in which the bases and perpendiculars of triangles have a propensity of assuming the position and dimensions of hypothenuses. A good set of maps, showing the real location of the different lines, would add immensely to the value of the book. On page 219 the weight of the consolidation engines on the Alton Railroad is given as 165 tons. What is probably meant is 165,000 pounds. But the book has the primary merit of being interesting, concise, and is well printed in large type, and in these days of much writing and printing, the reader will be grateful for these merits.

NEW CATALOGS.

IN WRITING FOR THESE CATALOGS PLEASE MENTION THIS PAPER.

INTEGRATING WATTMETERS.—Folder No. 4047 from the Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa., describes their new type B integrating wattmeter.

LIFTING MAGNETS.—The Electric Controller & Supply Company of Cleveland, Ohio, are sending out a bulletin which describes their lifting magnets, and presents several interesting illustrations of work which may be handled to advantage with them.

JEFFREY PULVERIZERS.—Bulletin from the Jeffrey Manufacturing Company, Columbus, Ohio, emphasizing the important features of their swing hammer pulverizers, which have renewable breaker plates, screen bars and chilled linings.

REVOLUTION IN BORING.—The Davis Expansion Boring Tool Company, 202 Commercial Street, St. Louis, Mo., have published a small folder which describes and considers the advantages of their new boring bar, which is specially adapted for boring car wheels.

ELECTRICAL APPARATUS.—The following bulletins have been received from the Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa.: No. 1,102, Westinghouse direct current multiple arc lamp for 110 and 220 volts; No. 1,104, portable instruments, and 1,113, belted type rotating field alternators.

ENGINES AND BOILERS.—The Atlas Engine Works, Indianapolis, Ind., have just sent out two very attractive catalogs, one describing their Atlas water tube boilers and the other their medium speed engines. The latter contains some very interesting information and data for engineers.

COLUMBIA SANDER.—We have received a handsome catalog from the American Wood Working Machinery Company, 136 Liberty street, New York, entitled "Success of the Columbia Sander," which describes in detail the essential features of this machine, and presents a number of strong testimonials from users. This sander is described on another page of this issue.

FRICTION DRAFT GEARS.—The Gould Coupler Company, No. 1 W. 34th Street, New York, have issued a handsome catalog describing their new friction draft gears for passenger and freight cars and locomotives and also a friction buffer for passenger coaches, baggage and express cars. The construction of these gears is very simple and a number of tests are reported, which show that it has a high capacity with a small recoil action.

LIGHTING.—The Crocker-Wheeler Company published during the National Electric Light Association Convention at Denver a pamphlet, entitled "The Vital Subject Is Lighting." The cover illustrates a broncho-busting exhibition, which was given in honor of the delegates, while the pamphlet itself considers the equipment manufactured by this company for supplying lighting for anything from a yacht, or house, to the streets of a large city.

THREAD MILLING MACHINE.—We have just received from the Pratt & Whitney Company, 111 Broadway, New York, a unique souvenir mailing card. Moving a small catch allows part of the back to spring open, and displays a folder which illustrates several pieces of work done on a Pratt & Whitney thread milling machine, and emphasizes the great economies afforded by this machine on certain classes of work by giving the time which was required to finish the various pieces.

AN ELECTRIFIED RAILWAY SHOP DESCRIBED BY ITS MECHANICAL ENGINEER.—Bulletin No. 58 from the Crocker-Wheeler Company, Ampere, N. J., contains a reprint in abridged form of the series of fourteen articles on the application of individual motor drives to the old machine tools at the McKees Rocks shops of the Pittsburgh & Lake Erie Railroad, which appeared in this journal beginning April, 1903. This bulletin will be of value to those interested in the application of motor drives to either new or old machine tools.

ROLLER BEARINGS.—The Hyatt Roller Bearing Company, Harrison, N. J., has issued a very unique bulletin, entitled "With Good Ammunition and a Dead Sure Aim You Can Always Count on a Bag Full of Game." At the top of each page is a small engraving showing some scene in the progress of a hunt, and beneath this is an appropriate selection from the records of the sales department. The first page is entitled, "Good Ammunition," and shows two of the standard Hyatt shafting boxes, and under "Straight to the Heart" is a report of a comparative test between Hyatt roller bearings and ordinary babbitted bearings.

CONDENSERS.—The W. H. Blake Steam Pump Company of Hyde Park, Mass., have just printed an attractive catalog, No. 25, which describes the jet surface condensers manufactured by them. These range in size from the horizontal jet condenser of 800 lbs. capacity in steam condensed per hour, to 26,000 lbs.; while the twin simple and compound air pumps and jet condensers range in capacity from 38,700 lbs. of steam condensed per hour to 135,000 lbs. Measured by the same standard, the surface condensers with air and circulating pumps are built in sizes ranging from 4,100 to 40,000 lbs. capacity.

NOTES.

ARNOLD COMPANY.—This company has just commenced the installation of a complete light, heat, power and compressed air equipment at the new Missouri Pacific shops, at Sedalia, Mo., all material having been purchased.

DIAMOND CHAIN AND MANUFACTURING COMPANY.—Mr. W. P. Culver, formerly with the Cleveland Motor Car Company, has been appointed eastern representative of the Diamond Chain & Manufacturing Company of Indianapolis, Ind., with headquarters in New York.

KENNICOTT WATER SOFTENER COMPANY.—This company announces that the Booth Water Softener Company, 126 Liberty street, New York, has passed into their control and will represent them in the East.

WESTINGHOUSE FRICTION DRAFT GEAR.—The Westinghouse Air Brake Company has just received orders from the Baltimore & Ohio Railroad system for the equipment of 10,000 of their cars with Westinghouse friction draft gear. This will make a total of 25,000 cars on the system equipped with this device. It is interesting to note in this connection that the Pennsylvania system has now a total of 70,000 cars equipped with this draft gear. This indicates how favorably the managers of the large railroad systems look upon this apparatus for the dissipation of shocks in the handling of long trains composed of heavy cars. One of the features of the tests shown the visiting members of the International Railway Congress when they were at East Pittsburgh was the efficacy of this apparatus to save wear and tear on rolling stock.

A LONG STEEL COAL TRESTLE.—The Maryland Coal Company has ordered a steel frame coal trestle 272 ft. long and 25 ft. wide, with steel tipple house 99 ft. x 25 ft. for their mines at Wendel, Taylor county, W. Va. The contract has been placed with Wm. B. Scaife & Sons Company, Pittsburgh, Pa.

Mr. J. B. Hicks, representing C. A. Willoy and the David B. Crockett Company, distributed attractive souvenirs at the Manhattan Beach conventions. The knives presented by C. A. Willey are of excellent quality and are specially appreciated. The perpetual calendar with clock attached, presented by the David B. Crockett Company, was one of the most attractive souvenirs at the conventions.

AMERICAN STEEL FOUNDRIES.—This company announces the receipt of an order from the Atlantic Coast Line for 1,000 cast steel body bolsters for 30-ton box cars, to be built at the shops of the South Atlantic Car & Manufacturing Company, at Waycross, Ga.; and 2,000 cast steel body bolsters for the same class and capacity cars to be built by the Western Steel Car & Foundry Company, at their Anniston plant.

WESTINGHOUSE ELECTRIC AND MFG. COMPANY.—This company has just closed a contract for the equipment of the main generating station and four rotary converter substations of the Cincinnati Northern Traction Co. The power-house will be located at Hamilton, Ohio, and the original installation will be of 5,000 k.w capacity, with provisions for ultimately increasing it to 10,000 k.w. In the generating station will be located three 1,500 k.w. and one 500 k.w., 3-phase, rotating field, enclosed turbo-type generators, and three 300 k.w. rotary converters. Each generator will be driven by a Westinghouse-Parsons steam-turbine and excited by a direct-current generator attached to the end of the turbine shaft from which its power will be derived. Each substation will contain a 300 k.w. rotary converter supplied by three 33,000-375 volt step-down transformers. All transformers are of the oil insulated self-cooling type. Besides the above, the contract includes all necessary switchboards and protective devices for the control and protection of apparatus in the power-house and rotary stations.

EXCELLENT DINING CAR SERVICE.—No feature of traveling is more thoroughly appreciated than acceptable dining car service. A group of railroad men met in the dining car of the B. & O. 3 p. m. train from Washington to New York, reaching New York at 8 p. m. on time. They agreed that the dining car service was the best they had ever enjoyed, the menu being as follows:

Royal Blue Line, Dining Car Service, Dinner.—Astrachan caviar; onion soup, au gratin; strained chicken gumbo; radishes, cucumbers, salted almonds. Baked Delaware shad, Venitienne; sliced tomatoes. Soft-shell crabs, saute meuniere. Larded fillet of beef, au jus; roast spring lamb, mint jelly; mashed potatoes, new potatoes, rissole; string beans; asparagus, au Beurre. Roast Philadelphia squab, au Cresson. Claret wine punch. Heart lettuce, au Mayonnaise. Pistache ice-cream, macaroons, lemon meringue pie, strawberry short cake. Nabisco sugar wafers. California cherries. Roquefort and Neufchatel cheese, toasted crackers. Black coffee. Creme de menthe.

NEW ENGLAND SEACOAST.—This seacoast, the ideal recreation ground during the summer, is preparing to welcome her visitors. In a short while the beautiful North Shore of Massachusetts, including Manchester-by-the-Sea, Marblehead, Clifton, Rockport, Devereux, Gloucester, etc., will be festive resorts, assembling together the foreign embassadors and Washington diplomats who especially favor this section. Hampton and Rye beaches in New Hampshire, delightful pleasure resorts, in a few weeks will harbor thousands of amusement seekers; York, Kittery and Kennebunk are ready for the cottagers. Old Orchard will appear more smiling than ever this year. Portland fronting on Casco Bay and the delightful islands have donned their summer apparel. North of Portland the shore resorts to Bar Harbor and beyond in New Brunswick are ready for the summer influx. You can scarcely appreciate the beauties of the sea coast without a visit; but there are two publications which will do much to enlighten you. A beautiful portfolio containing twenty-eight half-tone reproductions of seashore views will be mailed by the General Passenger Department, Boston & Maine Railroad, Boston, upon receipt of six cents. and a descriptive booklet entitled, "All Along Shore," will be mailed upon receipt of two cents in stamps.

MANNING, MAXWELL & MOORE, INCORPORATED.—On May 31st a very strong corporation was formed under the laws of New Jersey, consisting of the well-known house of Manning, Maxwell & Moore and its allied manufacturing companies, the Shaw Electric Crane Company, the Ashcroft Manufacturing Company, the Consolidated Safety Valve Company, the Hayden & Derby Manufacturing Company, the Hancock Inspirator Company and the United Injector Company. The officers of the new concern are: Charles A. Moore, president; John N. Derby, vice-president; Martin Luscomb, vice-president; Stephen B. Aller, vice-president; Colby M. Chester, Jr., treasurer; J. H. Blue, assistant treasurer; Charles Arthur Moore, Jr., secretary, and Merle S. Clayton, assistant secretary.

CHICAGO PNEUMATIC TOOL COMPANY.—Mr. J. W. Duntley, president of this company, has returned from Europe with orders for 3,400 pneumatic tools, representing a value of more than $300,000. His trip was remarkably successful, and on the Continent it was found necessary to establish manufacturing facilities by the purchase of the factory and business of E. G. Eckstein, Berlin, Germany. Also that of the Lencke Company at St. Petersburg. This has become necessary because of the rapid introduction of pneumatic tools into shop, building and other large industries on the Continent. All foreign countries being well equipped with electricity, the electric drill seems destined to rival the air drill, and open up a new field for this company abroad. The English company has won its suits covering 52 claims concerning pneumatic hammers, thus placing this company in a specially strong position with reference to its patents. The plant at Fraserburgh, Scotland, is now in full operation. The month of May has brought the largest volume of business in the history of the Chicago Pneumatic Tool Company.

KENNICOTT WATER SOFTENER COMPANY.—This company has acquired several acres of land at Chicago Heights, Illinois, and is constructing a new plant, the present quarters at 35th and Butler Streets, Chicago, having proved entirely inadequate to the needs of its constantly growing business. The new plant will consist of a main building 80 ft. wide by 300 ft. long, together with an office building arranged for office, drafting room and laboratories, 40 ft. by 46 ft., two stories high. The other buildings will consist of a power house 40 ft. by 50 ft., and a machine shop 35 ft. by 80 ft. The buildings will be of brick, steel, and tile construction throughout. The main building is to be equipped with a traveling crane of 80 ft. span, the crane being arranged to cover the entire area of the building, the roof of which is in a single span. The yard space is to be covered with a traveling crane of 26 ft. span, erected upon steel posts. Provision is made for the entrance of cars into the main building, so that loading and unloading may be done under cover. All tools are to be equipped with individual motor drive. Large purchases of machinery have been made to supplement the equipment already in use.

BOSTON & MAINE RAILROAD.— The pamphlet entitled "Hunting and Fishing," issued by this road, would stir the blood of those who understand the woods and know the effect upon a busy life of a sojourn near to nature. This pamphlet describes the Rangeley lake country, the Dead River region; the upper Kennebec; Moosehead lake and vicinity; the Aroostook region; Washington County, Maine, the lakes of New Hampshire, the fishing of the White Mountain region; Pennigewassete, Conn., lakes; Lake Champlain; Canadian Provinces and Newfoundland. The pamphlet contains an excellent map of the New England fishing and hunting resorts, and the attractions of these regions are presented in such a way as to lead the hunter or fisherman to immediately look over his tackle and outfit for a dream of an outing, which must necessarily eventually lead to a visit to this country. Copies of this pamphlet and the fish and game laws, also other excellent literature may be had upon application to Mr. D. J. Flanders, general passenger and ticket agent, Boston & Maine Railroad, Boston, Mass. This department also announces the resumption of through train service for the season of 1905 on the Connecticut River line between New York, Portland, Poland Springs, Bar Harbor, the Maritime Provinces, White Mountain resorts, Montreal and Quebec.

CONVENTION EXHIBITS.

At the exposition in connection with the Manhattan Beach conventions of the Master Mechanics' and Master Car Builders' associations the following were among the exhibitors present:

Acme White Lead & Color Works, Detroit, Mich.
Adreon Company, St. Louis, Mo.
Ajax Metal Company, Philadelphia, Pa.
American Balance Valve Company, Jersey Shore, Pa.
American Brake Shoe and Foundry Company, Mahwah, N. J.
American Lock Nut Company, Boston, Mass.
American Nut & Bolt Fastener Company, Pittsburgh, Pa.
American Steam Gauge & Valve Manufacturing Company, Boston, Mass.
American Steel Foundries, New York.
Andrews, J. S. & Co., New York.
Anglo-American Varnish Company, Newark, N. J.
Baldwin Locomotive Works, Philadelphia, Pa.
Baltimore Railway Specialty Company, Baltimore, Md.
Besly, C. H., & Co., Chicago, Ill.
Bettendorf Axle Company, Davenport, Ia.
Bordo, L. J. Company, Philadelphia, Pa.
Bowser, S. F., & Co., Fort Wayne, Ind.
Bradford Draft Gear Company, Chicago, Ill.
Browning Engineering Company, Cleveland, O.
Buckeye Steel Castings Company, Columbus, O.
Buda Foundry & Manufacturing Company, Chicago, Ill.
Butler Drawbar Attachment Company, Cleveland, O.
Carey, Philip, Manufacturing Company, Lockland, Cincinnati, O.
Chicago Car Heating Company, Chicago, Ill.
Chicago Pneumatic Tool Company, Chicago, Ill.
Cleveland Car Specialty Company, Cleveland, O.
Cleveland City Forge & Iron Company.
Commercial Acetylene Company, New York.
Consolidated Car Heating Company, Albany, N. Y.
Consolidated Railway Electric Lighting & Equipment Company, New York.
Davis Expansion Boring Tool Company, St. Louis, Mo.
Dearborn Drug & Chemical Works, Chicago and New York.
Detroit Graphite Manufacturing Company, Detroit, Mich.
Detroit Lubricator Company, Detroit, Mich.
Diamond Machine Company, Providence, R. I.
Dickinson, Paul, Chicago, Ill.
Dixon Crucible Company, Jos., Jersey City, N. J.
Duner & Co., Chicago, Ill.
Edwards Company, The O. M., Syracuse, N. Y.
Electric Controller & Supply Company, Cleveland, O.
Electro-Dynamic Company, Bayonne, N. J.
Falls Hollow Staybolt Company, Cuyahoga Falls, O.
Farlow Draft Gear Company, Baltimore, Md.
Federal Company, Chicago, Ill.
Flannery Bolt Company, Pittsburgh, Pa.
Foster Engineering Company, Newark, N. J.
Franklin Manufacturing Company, Franklin, Pa.
Franklin Railway Supply Company, Franklin, Pa.
Frost Railway Supply Company, Detroit, Mich.
General Electric Company, Schenectady, N. Y.
Gould Coupler Company, New York.
Hicks, J. D., representing C. A. Willey and the David B. Crockett Co.
Independent Pneumatic Tool Company, Chicago and New York.
Jenkins Bros., New York.
Kennicott Water Softener Company, Chicago.
McConway & Torley Company, Pittsburgh, Pa.
McCord & Co., Chicago, Ill.
Nathan Manufacturing Company, New York.
National Malleable Castings Company, Cleveland, O.
New Jersey Tube Company, Newark, N. J.
Norton Grinding Company, Worcester, Mass.
Pittsburg Spring & Steel Company, Pittsburgh, Pa.
Safety Car Heating & Lighting Company, New York.
Saint Louis Car Company, Saint Louis, Mo.
Shelby Steel Tube Company, Pittsburgh, Pa.
Standard Car Truck Company, Chicago, Ill.
Standard Coupler Company, New York.
Standard Steel Works, Philadelphia, Pa.
Star Brass Manufacturing Company, Boston, Mass.
T. H. Symington Company, Calvert Building, Baltimore, Md.
Thompson, C. A., St. Louis, Mo.
Underwood, H. B. & Co., Philadelphia, Pa.
Walworth Manufacturing Company, Boston, Mass.
Westinghouse Air Brake Company, Pittsburgh, Pa.
Westinghouse Air & Automatic Steam Coupler Company, St. Louis, Mo.
Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa.
Wood, G. S., Chicago, Ill.
Woods Machine Company, S. A., Boston, Mass.
Yale & Towne Manufacturing Company, New York.

WANTED—Foreman for tool department of large engineering works. Must be first-class man. Apply stating experience and giving references, "C," AMERICAN ENGINEER AND RAILROAD JOURNAL, 140 Nassau street, New York.

WANTED—General storekeeper for large engineering works and foundry. Must be competent man. Apply stating experience, salary expected, and giving references, "C," AMERICAN ENGINEER AND RAILROAD JOURNAL, 140 Nassau street, New York.

WANTED—Position by a master mechanic with fifteen years' experience in charge of large shops. Would accept position as mechanical engineer or take charge of manufacturing plant. Boiler work and design a specialty. Would not object to travel. Address "A," care Editor AMERICAN ENGINEER.